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Work-study

It is the opinion of many in foundry circles that work-study is the most important factor for the future progress of the industry. The first reaction by the average small foundry owner is that it involves spending much money on complicated machinery. For mass-production foundries, this is probably true, but in some cases it may mean the retention of manual work. One foundry manager having to make a decision as to whether to electrify completely an overhead crane, studied and timed its movements for an hour or so and was convinced that operation by push-button from floor level was infinitely cheaper than having a crane driver sitting in his cab all day long.

Mechanized foundries have made progress towards efficiency, as a result of work-study. When moulding machines were first introduced, they converted the operators from sand punchers into porters. Then came the length of roller pathway which limited porterage to taking the mould from the machine to the conveyor. Other developments followed, until now the mould is automatically pushed from the machine. Similar action was taken at the knock-out station and more labour was conserved. More recently, the striking off of surplus sand from boxes and the movement and dwell time of slinger heads over moulds has been made automatic. These developments are just as important as time-and-motion study, especially for the foundry industry.

The most pressing work-studies at the moment are those connected with the newer processes. In general, they are just about on a par with the installation of the original moulding machines. Moulds and cores made by either the shell-moulding or CO_2 processes are unquestionably efficient, but pre-service and post-handling leave much to be accomplished. Recently, an American firm using the CO_2 Process reported the great strides they had made technically with the method and said they were now devoting their energies to its mechanization. Without work-study, some of the major benefits of new processes are being lost. That—now well-known—series of questions starting "why is the job being done here?" and finishing with "could it be done better?" is the real basis of work-study. Time-and-motion study is merely one of the ancillary tools for ascertaining the true position. Obviously, a person undertaking such studies must take a completely detached view, as would a Harley Street consultant who has no prior knowledge of the patient's medical history. A foundry manager capable of inducing this state of mind is a real asset to his employers. There is always the danger, that, when a foundry has been thoroughly reorganized and re-tooled, for far too long after the completion of the work, the manager thinks his shop represents the last word in progress.

Science Museum Exhibition

Two special exhibits have been currently arranged by the Science Museum, South Kensington, London, as follow:

Weather Charts by Radio. A Mufax chart recorder, for displaying facsimile picture transmissions of weather charts, is now on exhibition. It has been lent by the makers, Muirhead & Company, Limited, and reproduces a whole chart in 35 minutes or less depending on the speed setting, and, throughout the recording, the progressively growing chart is visible on a flat platen. The exhibit can be shown in operation and will normally be used to record transmissions broadcast from Dunstable Meteorological Station at 12.10 and 4.50 p.m. This exhibition will continue for about six months.

Bristol "Proteus" Turboprop Aero Engine. The Bristol "Britannia" aircraft, which has just gone into passenger service with BOAC, is powered by four Bristol Proteus "turboprop" aero-engines. A sectioned example of this engine, exhibited in motion in the Aeronautical gallery at the Museum, clearly illustrates the great progress this country has made in the design of gas-turbine engines for aircraft.

* Hours of opening: Weekdays, 10 a.m. to 6 p.m.; Sundays, 2.30 to 6 p.m. (closed on Good Friday). Admission free.

Transit of Enamelled Products

The newly-formed Vitreous Enamel Development Council are undertaking a programme to improve the packing of vitreous enamelled products to minimize damage in transit, which will be conducted on the line of the successful Safe Transit Programme adopted in the United States. There, very high losses from damage in transit were reduced to such a marked degree that from being a daily hazard it is now almost unheard of for loss to be sustained in this manner.

The essence of the Safe Transit Programme is that close co-operation is maintained between specialist companies manufacturing package materials and the manufacturers of the vitreous-enamelled products. Packs designed specifically for a particular product are rigorously pre-tested by special machines which simulate the type of conditions most likely to cause damage.

Apart from the obvious savings such a programme can bring in cutting down the "dead loss" of replacement, insurance companies are expected to give preferential rates for enamelled products packed in an approved manner.

Forty Years Ago

The February 1917 issue of the FOUNDRY TRADE JOURNAL was not exactly of vintage quality. Stories about the electric furnace do not merit re-reading. Turning to an article on cores, one learns that making a job in the conventional way cost £4 13s. 0d. made up of sand and mixing, 3s.; core irons, 15s.; making cores, 45s.; dressing and blackwashing, 10s.; and dressing castings, 20s. For oil-sand cores the cost was £2 18s. 6d. including sand and mixing 3s.; 2 galls. of oil, 8s.; making cores, 30s.; dressing and blackwashing, 10s.; and dressing castings, 7s. 6d.

Index to Vol. 101

The index to the JOURNAL, volume 101, covering the period July to December, 1956, has now been printed and is available to readers free of charge. Applications for copies should be addressed to the publishing office, FOUNDRY TRADE JOURNAL, John Adam House, John Adam Street, Adelphi, London, W.C.2. Subscribers who wish to receive copies of indices automatically as they are printed may apply for inclusion on a permanent mailing list. Those already on the list should not need to apply for their current copy.

Giant Weighers

Two giant crane-weighers seen (left) prior to their despatch from Geo. Salter and Company, Limited, West Bromwich. One of these is for Babcock and Wilcox, Limited, at Renfrew, and the other is bound for Calcutta for use by the Docks Commissioners. These weighers, slung from cranes, enable loads of up to 100 tons to be weighed and moved in one operation.

Origin of Graphite in Cast Irons

By J. E. Harris, B.Sc., and V. Kondic, B.Sc., Ph.D.

Some types of the graphite phase in cast irons can form during solidification whilst others can be obtained by decomposition of Fe_3C in the solid state. The effects of alloy composition and molten-metal treatment, as well as the rate of cooling during and immediately following the solidification, have been studied in relation to the graphite formation by both of these processes. The results obtained show that the decomposition of Fe_3C into Feδ and graphite during, and immediately after, the solidification can be of far more frequent occurrence than has been hitherto considered. On the bases of these results, a theory for the mechanism of graphite formation in hypo-eutectic cast irons has been put forward. The mechanism assumes that, in general, the graphite phase can form in these cast irons through the decomposition of Fe_3C. The first part of the account, published this week, carries the reader up to the Authors' commentary on their results.

Introduction

Cast irons are rather unusual amongst industrial alloys. Changes that may occur during and after the solidification are very numerous and are affected by a large number of variables. This is the main reason why, as yet, no generally acceptable theory is available which could explain the origin of different phases in cast irons. Amongst the problems of cast-iron's structure, perhaps the most fundamental and basic one is that of the origin of graphite. Before giving a brief review of the past work in this field, it is advantageous to state the nature of the main problems concerning the formation of graphite in irons.

The somewhat complex nature of some of the solidification phenomena is largely founded on the complexity of the liquid state in general. The liquid state of alloys is as yet little understood and gives only vague clues on the problems concerning the formation of cast structures. The process of solidification itself, on the other hand, has been better explored, both theoretically and practically. Referring to the schematic Fe/C diagram (Fig. 1), it is seen that for an alloy X, the primary crystals of Feδ at the end of solidification will be found in the matrix of a eutectic. The experience shows that the carbon-rich phase of this eutectic may be present either as Fe_3C (ledeburite or white-iron eutectic) or as graphite flakes (grey iron). Such graphite flakes vary in size and shape, as well as in distribution and the three outstanding variants are shown schematically in Fig. 2, known in American terminology as A, D (or undercooled) and nodular (or s.-g.) graphite. From these observations, two basic problems concerning the state of graphite in cast irons can be already given: first, why is the Fe_3/C phase in the eutectic replaced under certain conditions by the graphite phase and second, why do the graphite phase, shape and distribution vary in the above manner?

For the sake of simplicity the binary alloy Fe/C will be considered in some illustrations as well as in

The Authors:

Mr. V. Kondic, B.Sc., Ph.D., graduated in mechanical engineering (Belgrade, 1937), and like many other engineers got interested in metals and obtained a Ph.D. in metallurgy (Birmingham, 1942). Since then his work has been mainly in the field of applied metallurgy, partly due to his past training in engineering and largely due to his present interest in metal founding. He has been holding the position of lecturer in founding from the time of formation of the Department of Industrial Metallurgy at Birmingham University in 1946 up to the present date.

Mr. J. E. Harris is at present working in the research laboratories of the British Thomson Houston Company, Limited, Rugby. He was born in South Wales in 1932, and attended Larkfield Grammar School, Chepstow. In 1950 he became a student in the metallurgy department of Birmingham University, and after graduating in industrial metallurgy, he carried out research work in that department.

the comments; but all the experimental work described in this Paper and all the points advanced, in fact concern the ternary Fe/C/Si alloy, with all the customary impurities encountered. The binary cast-iron alloy Fe/C turns out to be ledeburitic with ordinary methods of cooling and the problem of graphitization proper is met with mainly with ternary and more complex alloys.

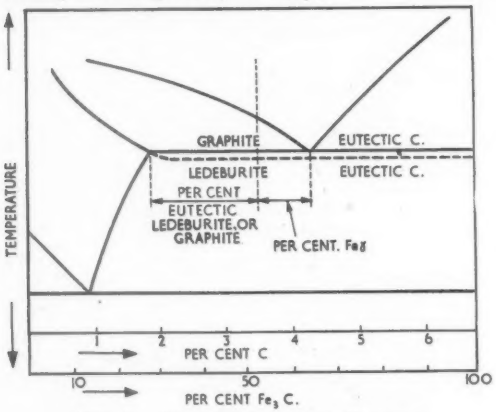


FIG. 1.—*Iron/carbon phase diagram.*

Explanations Sought

The two methods of practical significance of controlling changes in cast-iron structure to the desired end are well known: namely adjusting the alloy composition and the rate of cooling. However, whilst knowledge is available how to secure

FIG. 2.—*Major variants in graphite types: (a) flake "A"; (b) undercooled "D" and (c) nodular (s-g).*

white or grey-iron structure in industrial practice, or this or that type of graphite in a casting, the exact mechanism whereby these changes are brought about is not yet clear. The effects of the rate of cooling and that of composition, as well as that of many other treatments that are used in cast-iron metallurgy to control structures, all follow from the two basic problems stated earlier.

The third basic problem of the structure of cast irons concerns the shape and distribution of different types of graphite that may form in the solid state. Ledeburitic white-iron castings are commonly made graphitic by an annealing process (malleablizing) which results in a new series of types of graphite in the structure. The question then arises, whether the graphite types produced by malleablizing are in any fundamental way different from those obtained during solidification.

The object of the present Paper is that of briefly reviewing past evidence and the resultant theories

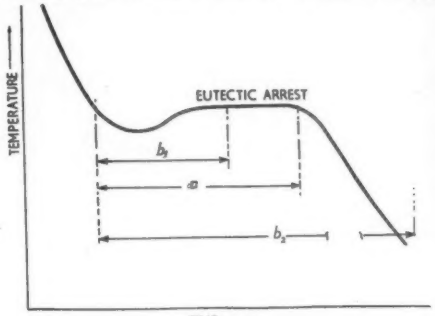


FIG. 3.—*Cooling curve of a typical cast iron.*

concerning the three problems stated and then presenting the results of some experiments concerning the formation of graphite. On the bases of all the evidence available, a general mechanism of formation of graphite in hypo-eutectic cast-irons is later put forward.

PREVIOUS WORK

Experimental Evidence

One of the oldest and most-widely-used methods for following the changes taking place of an alloy during solidification is the thermal analyses. Two important points have emerged from such studies of

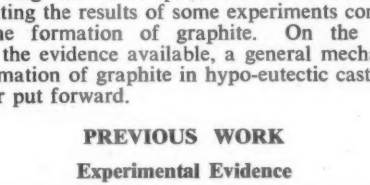


FIG. 4.—*Chill test of cast-iron structure.*

solidification of cast irons. First, the cooling curve of a cast iron is most frequently of the shape shown in Fig. 3 and second, for a given iron the temperature of undercooling as well as that of the eutectic are not readily reproducible[1]. This second observation is so important that some workers have used repeated cooling and heating curves on the same sample in order to obtain the values of ledeburite- and graphite-eutectic respectively[1]. This type of thermal analysis gives what is generally known as

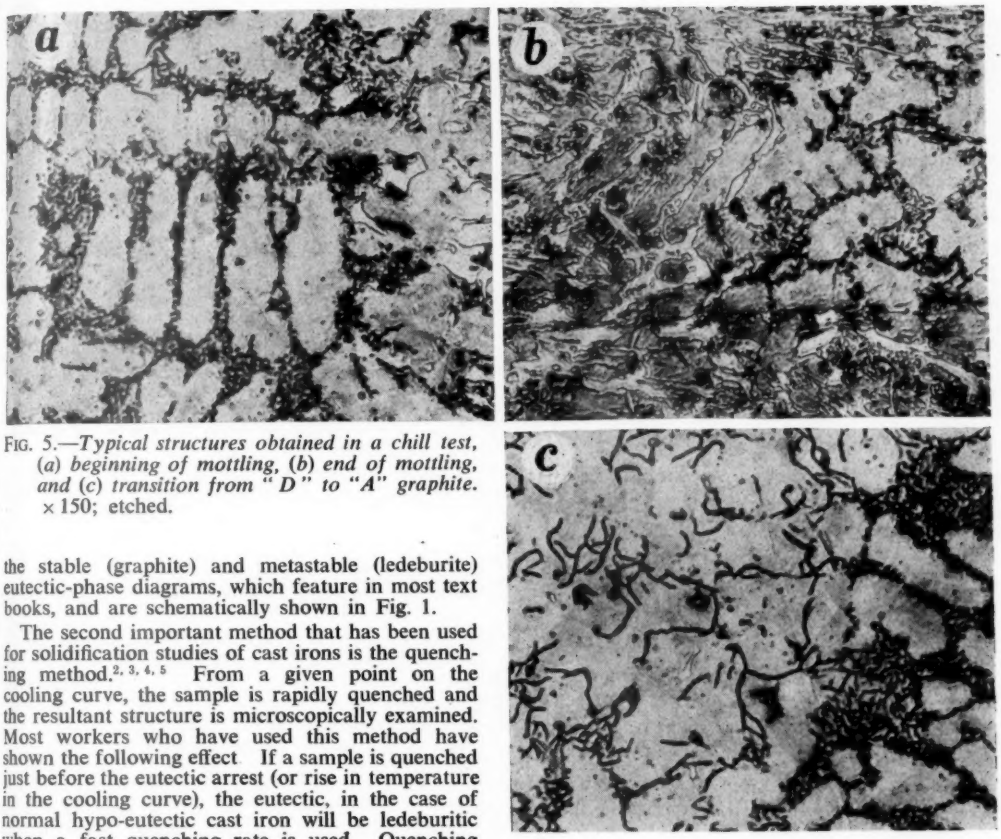


FIG. 5.—*Typical structures obtained in a chill test, (a) beginning of mottling, (b) end of mottling, and (c) transition from "D" to "A" graphite.* ×150; etched.

the stable (graphite) and metastable (ledeburite) eutectic-phase diagrams, which feature in most text books, and are schematically shown in Fig. 1.

The second important method that has been used for solidification studies of cast irons is the quenching method.[2, 3, 4, 5] From a given point on the cooling curve, the sample is rapidly quenched and the resultant structure is microscopically examined. Most workers who have used this method have shown the following effect. If a sample is quenched just before the eutectic arrest (or rise in temperature in the cooling curve), the eutectic, in the case of normal hypo-eutectic cast iron will be ledeburitic when a fast quenching rate is used. Quenching during the arrest on the other hand shows a number of possible effects mainly dependent on the alloy composition and the cooling rates used, both during and after the solidification. Thus, for example, an iron which shows the graphite phase in the eutectic if left to solidify slowly, reveals, if quenched during the arrest, that a part of the eutectic contains graphite, whilst the remaining part of the eutectic is ledeburite. The relative amount of graphite (formed before quenching) and ledeburite (formed during the quench) are dependent on the position of the point on the cooling curve from which the quenching took place. An iron which would solidify white on slow cooling, gives if quenched, half way during the arrest, a completely ledeburitic eutectic. With suitable iron composition, the part of ledeburite formed before, can be distinguished from the ledeburite formed during the arrest. Such information obtained by the quenching experiments has been used to formulate different theories of graphite formation as discussed subsequently.

The third method that has been used to study the mechanism of solidification of cast irons is based on the measurement of volume changes that occur during solidification[6]. A marked volume contraction that occurs with the formation of ledeburite can be distingushed from the solidification process when graphite forms; in which case little bulk volume change of the specimen takes place.

A general criticism can be made of the three experimental techniques described. Clearly, the temperatures of solidification of ledeburite and graphite eutectics are very close. Furthermore, it is well established that graphite and not Fe_3C is the stable phase in these eutectics. However, none of the three experimental methods has been conclusive in determining whether during solidification the Fe_3C phase could be so short lived that its existence during solidification may not have been suspected from the examination of the structure at room temperature.

Theories of the Origin of Flake Graphite

At present, two different mechanisms of the flake-graphite phase formation in cast irons have been suggested. The direct mechanism assumes that graphite forms during solidification by the process of nucleation and growth directly from the liquid,

akin to the formation of any solid phase during freezing of an alloy[2, 5, 7, 8, 9]. The basic experiment on which this theory is founded is that of quenching. When eutectoid solidified before the quench shows the graphite phase whilst the remainder of the eutectic which solidified during the quench is ledeburitic, then, it is argued, the graphite in the eutectic could have formed only directly from the melt. This theory therefore ignores the possibility of short life existence of Fe_3C during the solidification process.

The second mechanism which has been proposed is that which assumes that ledeburite may form during the eutectic freezing and then the Fe_3C of the ledeburite decomposes either immediately, during, or soon after, the solidification, according to the speed of the reaction $Fe_3C \rightleftharpoons 3Fe + C$[10, 11]. This view has been proposed originally on the bases of volume-change measurements and subsequently on the bases of some quenching experiments. Whilst it is true that a conclusive proof in support of such an indirect mechanism of graphite formation has been lacking, it can be equally strongly argued that the evidence based on the quenching experiments in support of the direct mechanism is also not fully conclusive.

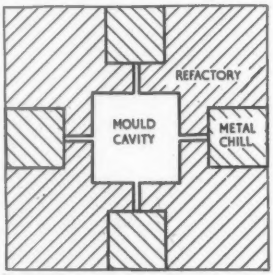


FIG. 6.—*Horizontal view of the mould used for the stripping experiments.*

In addition to the views supporting either the direct or indirect theory of graphite formation, a third possibility has been suggested by a number of investigators. In general, the bulk of experimental evidence in support of the direct theory has been obtained using irons of C and Si contents approaching the eutectic composition, whilst the support for the indirect theory has been obtained mainly with the hypo-eutectic irons well below the eutectic composition. Consequently, it has been argued that graphite may form during solidification directly or indirectly and that the decisive factors will be the composition of the melt and the rate of cooling[1, 11]. This school of thought has particularly supported the argument that the eutectiferous type of graphite (D-type, or undercooled variety) results by the decomposition process, whilst the more usual flake-type (A-graphite) results by the direct-growth mechanism[3, 4]. The basic arguments of the origin of spheroidal-type graphite will be dealt with later.

REASONS FOR PRESENT WORK

The brief review given indicates that different possibilities of flake-graphite formation exist. It is only fair to say that at present the direct theory is in ascendance in the number of supporters if not in novelties of their experimental methods or their arguments. But it is equally fair to say that much more (both experimental and theoretical work) is required to clarify all the issues involved. It is the object of the present Paper to provide some further evidence in support of the indirect mechanism, with-

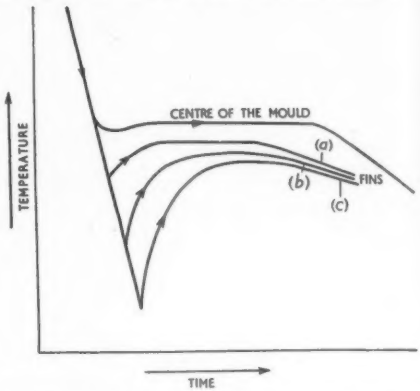
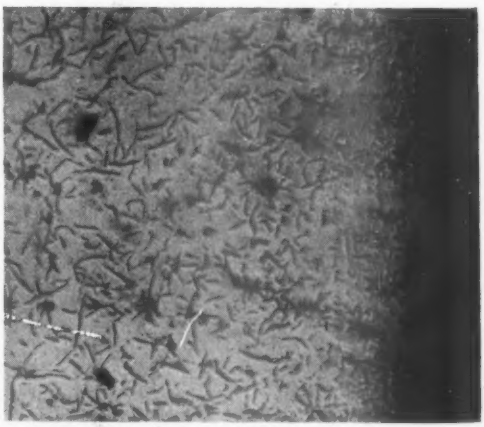


FIG. 7.—*Typical cooling curves obtained in the stripping tests.*
(*a*) Stripping after two sec.; (*b*) stripping after four sec. and (*c*) after eight sec.

FIG. 8.—*Structure of the chilled end of the fin after stripping, showing a completely decomposed ledeburite.* Etched ×50.



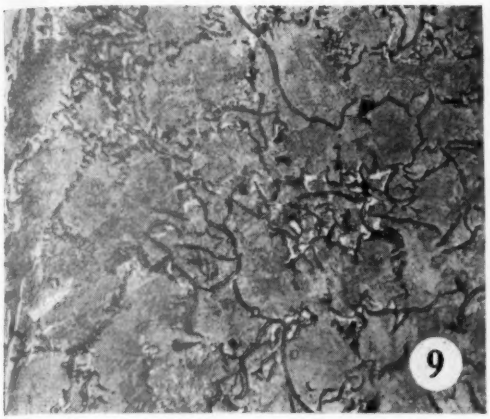


FIG. 9.—*Etched structure of the heat-affected zone of an ingot originally consisting of white iron. Ledeburite shown is that of the weld pool;* × 500.

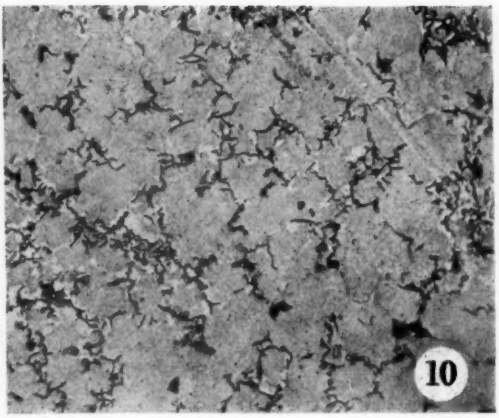


FIG. 10.—*Etched structure of the sample as shown in Fig. 9 but further away from the weld pool;* × 500.

out in any way claiming to finalize all the arguments.

A number of unsatisfactory points in the direct theory can be readily found; some of these can be illustrated by carrying out what is well known as the "chill test" of cast-iron structure. A sample of nominally grey-iron composition is poured against a cold metallic mould-face, the remainder of the casting being cooled relatively slowly in sand. The resultant types of structures are shown schematically in Fig. 4 and typical microphotographs in Figs. 5, (*a*) (*b*) and (*c*). A white ledeburitic zone which forms nearest to the cold mould-face changes into a mottled zone and eventually into the grey structure. The type of graphite frequently found in the mottled zone is of the "D" or fine eutectic variety, the quantity of this increases on approaching the grey zone. Then some "A" or normal flake-types of graphite are found, which eventually are typical of the whole of the grey zone. All the graphite in the mottled zone including the isolated island regions, Fig. 5 (*a*), would have formed, according to the direct theory, from the liquid and therefore would have been the first portion of the eutectic to solidify in this particular region; the remainder of the liquid then solidifying as ledeburite eutectic. Two questions can be asked: First, why do the grey eutectic colonies of the mottled zone form in front of the directional ledeburite growth away from the chilled face; and second, once started, why do these grey colonies stop growing? Examples of independent nucleation in a metallic liquid in front of directional-growing crystals are well known, particularly in non-ferrous alloys, and their explanation usually involves an assumption of increased concentration of solute adjacent to the growing surfaces, thus causing the liquid poorer in solute, and well in front to start with an independent nucleation. Therefore it would have to be assumed that the grey eutectic colonies of the mottled zone form owing to the existence of carbon or silicon concentration gradients in the liquid—an assumption for which there is no experimental evidence.

Even assuming the possibility for such an independent nucleation, the second question still remains, namely, why is it that the grey colonies once started, stop growing? An explanation of this question requires further assumptions of either (*a*) that another concentration gradient had been built-up; (*b*) that fast-growing ledeburite from the cooling face may consume the residual eutectic-liquid around the grey eutectic colonies, or (*c*) the possibility of the existence of a non-uniform heat flow may be suggested to explain the origin of grey eutectic in the mottled zone. According to this view, the rate of cooling is initially very rapid, but it drops appreciably soon after the skin formation on the solidifying samples. The grey eutectic colonies may therefore form at the end rather than at the beginning of eutectic solidification in the mottled zone; if this were so, it is difficult to ex-

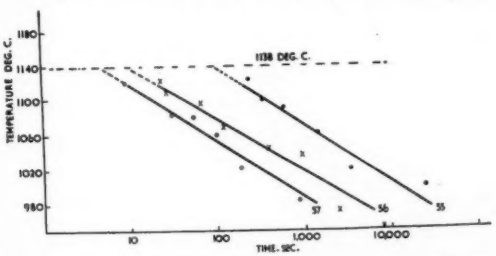


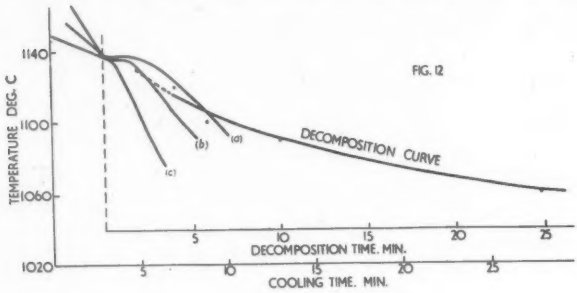
FIG. 11.—*Decomposition curves for irons S5, S6 and S7.*

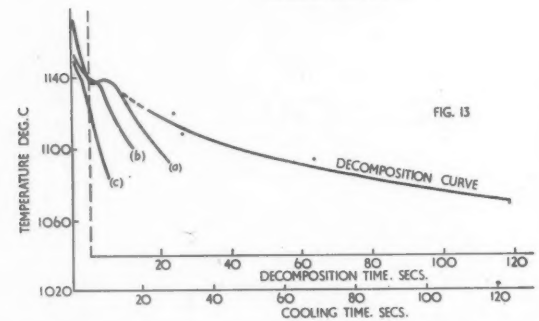
plain why these grey eutectic colonies are broadly spherical in their macro outline. Such difficulties of the direct theory in explaining what must be considered as the basic experiment in cast-iron structure studies are not made easier, if one considers the experimental data obtained by the thermal analyses. Some of the recent experimental evidence shows that the ledeburite eutectic temperature is higher than that of graphite (which is opposite to the usual text-book explanation). It is difficult to reconcile the existence of two distinct temperatures of formation with the existing structure of the mottled zone.

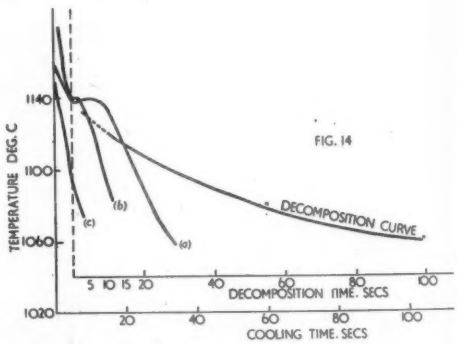
The indirect theory meets little difficulty in comparison with the direct theory in explaining the structural changes that are obtained by the chill test. According to the indirect view, the stability of cementite in the ledeburite eutectic is essentially controlled by the composition of the iron, and temperature, and time variables of the solidification process. When a suitable combination of these three variables is met, the ledeburite which has formed away from the chill mould-face begins to decompose owing to (*a*) relatively longer solidification time and (*b*) considerably longer time which is spent in the mottled zone at temperatures in the solidus range (owing to the heat of fusion flow from the slower-cooled parts of the sample). In other words, the grey colonies of the eutectic in the mottled zone are the result of kinetic factors operating in the solid state during the solidification process; rather than the consequence of different nucleation mechanisms directly from the liquid.

Consideration of further data for the explanation of the origin of graphite in the mottled-zone structure will be made later. With this evidence obtained, it is then proposed to re-examine the broad question of the origin of graphite in the hypo-eutectic cast irons.

In addition to the more theoretical arguments concerning the origin of graphite in cast irons, some practical observations have been made which are difficult to reconcile with the direct theory. For example, it has been shown that cast-iron rods can be made by pouring the metal into water-cooled moulds and still be grey throughout, if the rod is continuously withdrawn from the mould, allowing the white skin of the rod to be reheated by the unsolidified central part[12]. A similar phenomenon is involved in the manufacture of iron gutters by the gravity-die-casting process[13].







FIGS. 12 *to* 14.—*Cooling curves and decomposition time of various irons. (a) Sand mould, structure mottled; (b) carbon mould, structure white, and (c) metal mould, structure white; Fig.* 12 *for Iron S5; Fig.* 13, *Iron S6; Fig.* 14, *Iron S7.*

Experimental Work

The experimental work carried out in this investigation falls into three different groups: reheating experiments; kinetic studies, and quenching tests.

Reheating Experiments

It has been suggested earlier that a white-iron skin solidified on a casting can be rendered graphitic by utilizing the latent heat of fusion of the central parts of the casting to reheat the solid skin to temperatures below the eutectic temperature. A specially-designed mould (Fig. 6) was used to carry out such experiments under controlled conditions. The metal is poured into the central cavity made in a refractory and the fins of the casting are chilled against heavy metallic blocs. These chill

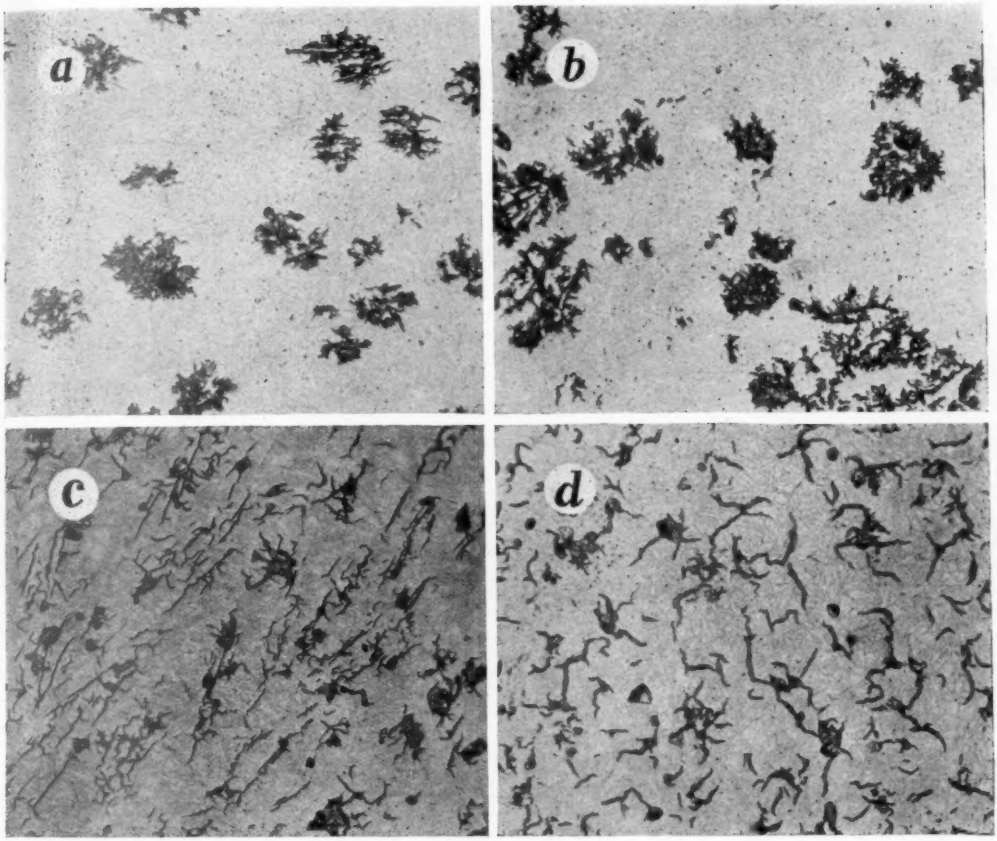
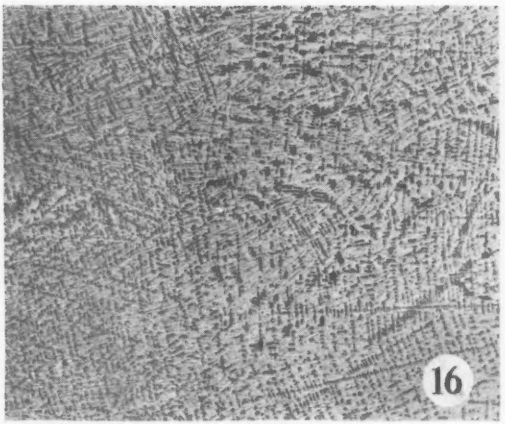


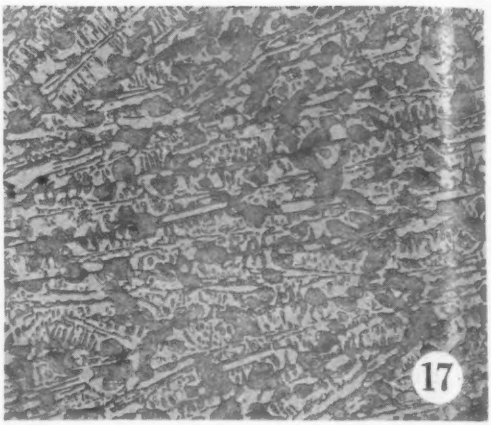
FIG. 15.—*Graphite types obtained in iron S6, decomposed at different temperatures:* (*a*) 950, (*b*) 970, (*c*) 1,040 *and* (*d*) 1,070 *deg. C.; etched* × 400.

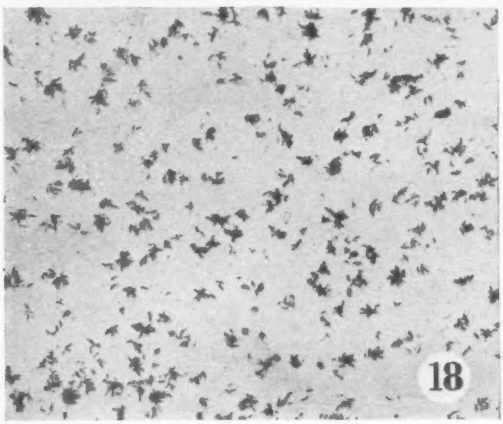
blocs are then lifted out at a predetermined time after the solidification of fins. Typical cooling curves taken immediately below the chill surface of a fin, shown in Fig. 7, reveal that the skin is initially cooled very rapidly and then reheated after taking the metallic chill out of the mould. A typical microstructure of the chilled face, when the chill bloc is stripped 2 sec. after the complete solidification of the chilled face of the fin, is shown in Fig. 8. Two main conclusions were obtained from such stripping experiments: (*a*) that a white skin decomposes fully and very rapidly (order of seconds) at temperatures below but close to the eutectic temperature and (*b*) that different types of graphite can be obtained through such a decomposition process, some types resembling the normal "A" type, whilst in some cases "D" graphite type of structure was obtained. Similar experiments were carried out with nodular irons, in which case the white-chilled layer at the surface gives rise to typical nodular or s.-g. iron structure after the decomposition.

Another "quick"-type experiment, which can be used to demonstrate the instability of Fe_3C at high temperatures is based on "spot" welding. If a thin ingot of white iron is rapidly heated locally to produce fusion, then, adjacent and below the fusion zone a whole series of graphite structures can be obtained within a few seconds (Figs. 9 and 10). It was confirmed by taking cooling curves and by etching techniques that these graphite structures were products of decomposition of Fe_3C.

A very precise control of all the variables is very difficult in the experiments described above. Consequently, these experiments were discontinued for the reason that they could not be made readily quantitative. They were replaced by kinetic and more quantitative studies. The experiments described have shown, however, that the order of mag-







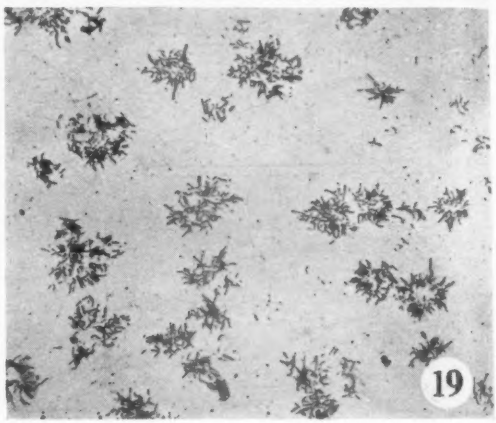


FIG. 16,—*Ledeburite of ingot of iron S8 cast into metal mould; etched* × 100.

FIG. 17.—*Ledeburite of ingot of iron S8 cast into sand mould; etched* × 1,100.

FIG. 18.—*Decomposition graphite of ledeburite shown in Fig.* 16 *obtained at* 1,050 *deg. C.; etched,* × 100.

FIG. 19.—*Decomposition graphite of ledeburite shown in Fig.* 17 *obtained at* 1,050 *deg. C.; etched,* × 100.

nitude of time required, to decompose Fe_3C at sufficiently high temperatures is very short indeed.

Kinetic Experiment Series

The problem of the decomposition of Fe_3C in the solid state (the malleabilizing process) has been studied by numerous investigators[14, 15]. The main shortage of data appears to be on the following two aspects: (*a*) the effect of the type of ledeburite eutectic in the original structure upon the decomposition time and structure and (*b*) the kinetics of the decomposition at high temperatures as functions of the iron composition. Four different types of experiments were carried out in this series.

Unless otherwise stated, the following Swedish iron was used for the bases of all the experiments to be described: C 3.97, Si 0.15, Mn 0.02, S 0.01, P 0.024, Ni 0.03 and Sb <0.001 per cent. The various C and Si contents were obtained by adding pure iron (BISRA) C 0.14, Si 0.003, Mn 0.052, Ni 0.11, Cr 0.02, Mo <0.02, W <0.02, V <0.03, Ti <0.02, Cu <0.15, . Al <0.005, Sn <0.02 and Pb <0.05 per cent. and a temper alloy Fe 5, Si 95 per cent. The various iron compositions used are listed in Table I.

TABLE I.

Alloy.	Carbon, per cent.	Silicon, per cent.
S4	2.71	0.51
S5	3.12	0.61
S6	3.81	1.58
S7	3.62	1.95
S8	3.97	0.15

Lead-bath Isothermal Treatment (*Reheating from Room Temperature*)

The procedure used in these experiments was as follows. White-iron rods ($\frac{1}{8}$-in. dia.) were obtained by pouring the alloys, S5, S6, S7, into cast-iron moulds and the rods were then cut into thin discs ($\frac{1}{16}$-in. thick). Subsequently, the discs held in a Ni-alloy wire loop, were immersed into a lead bath, at different temperatures and for different lengths of time. After the treatment, the discs were quenched in iced brine. The extent of Fe_3C decomposition was obtained by microscopic examination of the quenched structure. The results, for three different grey-iron compositions are shown in Fig. 11; the decomposition times were plotted in relation to the cooling curves (used in the experimental series "C") and the results are shown in Figs. 15 (*a*), (*b*), (*c*) and (*d*). It is evident from the data given that the stability of Fe_3C is chiefly controlled by (*i*) composition of the iron and (*ii*) malleabilizing temperature. This second variable largely controls the type of graphite which is obtained in the microstructure of the irons used. This is the main reason why it was found essential in these and other experiments to use a small sample which reaches the temperature of the bath very rapidly. By this means it was possible to avoid the presence of lower temperature graphite products in the malleablized structure, otherwise such products may form in the lower temperature region before the sample reaches the equilibrium temperature of the bath.

Lead-bath Isothermal Treatment (*Reheating Immediately after the Solidification*)

In this series of experiments a silica tube ($\frac{1}{4}$-in. dia. bore) carrying a centrally-located thermocouple, was immersed into the bath of molten S4 iron. The tube was then withdrawn with a solidified sample, the cooling curve being taken simultaneously. When the sample temperature fell to 1,000 to 1,050 deg. C., the silica tube with the sample was immersed for different times into a lead bath held at different temperatures. Thus, the significant difference of these experiments in comparison with the previous ones, was that the sample had not been cooled to room temperature (apart from some check tests) prior to the isothermal decomposition treatment. The type of structures obtained correspond to those observed in the preceding series. The results obtained by these experiments show (*a*) a similar time/temperature decomposition relationship of Fe_3C as that described in the preceding section (Fig. 11) and (*b*) that the type of graphite product obtained by the immediate isothermal treatment is in no way basically different from that obtained on reheating from room temperature. Consequently, the experimental methods involving reheating from room temperature was used for the remainder of kinetic experiments.

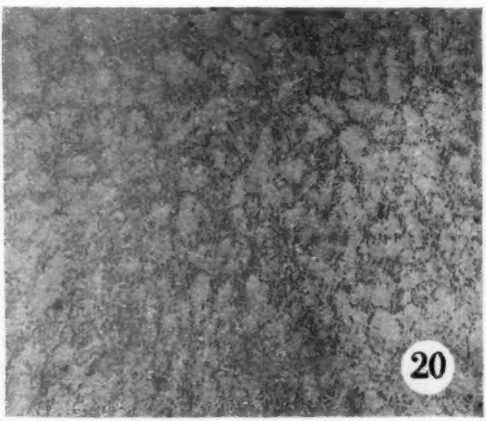
Isothermal Decomposition in Vacuo

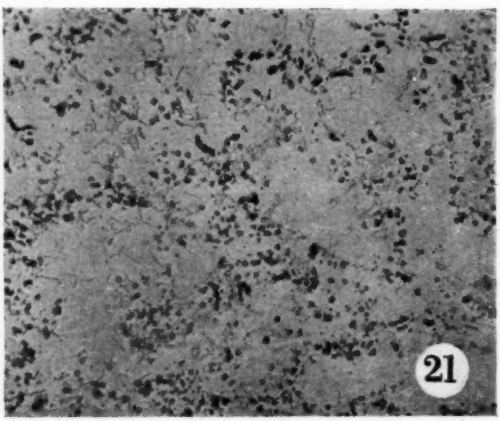
It was of interest to carry out similar experiments as those using a lead bath, but by enclosing the sample of iron, S5, in a silica tube sealed *in vacuo* instead of exposing the sample directly to the molten lead. The type of graphite obtained in this way was not significantly different from the types already described. Similarly, the decomposition time of Fe_3C was similar to that obtained when using lead baths at the corresponding temperatures.

Effects of the Type of Ledeburite on the Kinetics of Isothermal Decomposition

Different degrees of coarseness of the ledeburite eutectic, of a given iron composition, can be obtained by varying the rate of cooling of the sample during solidification. For this purpose a series of ingots ($1\frac{1}{2}$-in. wide, 6-in. long and of different thickness) were cast into cast-iron, graphite and sand moulds at room temperature and into hot (800 deg. C.) refractory moulds. In this way, it was possible to obtain a variation in ledeburite

FIGS. 20 *and* 21.—*Decomposition product of white iron, S7* (*etched*); *Fig.* 20 (*left*) *at* 1,100 *deg. C.*, × 100, *and Fig.* 21 *at* 1,050 *deg. C.*, × 250.





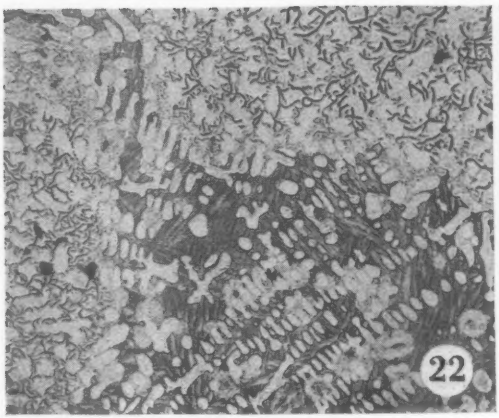


FIG. 22.—*Structure of iron S6 obtained on quenching 10 deg. C. below the eutectic arrest temperature; etched,* ×35.

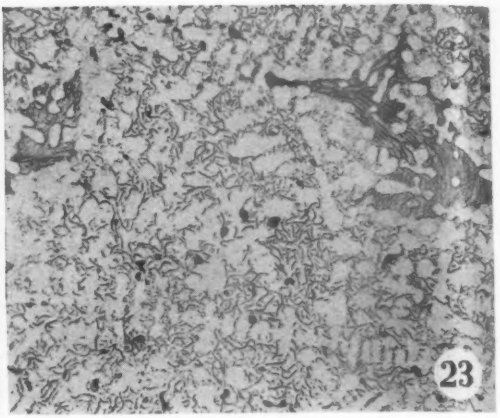


FIG. 23.—*Structure of iron S6 obtained on quenching 25 deg. C. below the eutectic arrest temperature; etched,* ×35.

structure such as shown in Figs. 16 and 17, these specimens were then subjected to an isothermal treatment as previously described. The types of graphite obtained at the temperature of 1,050 deg. C. when starting with ledeburite of different coarseness, are shown in Figs. 18 and 19. When comparing the decomposition times of these samples it is shown that fine ledeburite decomposes faster than the coarse ledeburite; thus, this factor appears also to be a significant variable in the studies of stability of Fe_3C at different temperatures.

In addition to the irons used for the previous experiments where C and Si were the main composition variables, a number of experiments were carried out with Mg-Ni treated alloys. The iron used (S7) was made from the same stock as the previous series, however, before pouring, the melt was treated with 1.4 per cent. of Mg-Ni (Mg 15, Ni 85 per cent.). White-iron samples obtained were subjected to the same type of isothermal treatment as those described. The type of white-iron structure before the isothermal treatment is the usual ledeburitic—the types of graphite produced after an isothermal decomposition at 1,100 and 1,050 deg. C. are shown in Figs. 20 and 21. A time/temperature decomposition graph of this iron was not established owing to the difficulties of estimating the end of transformation, but some of the times obtained were of the same order of magnitude as in the previous series of experiments with equivalent composition. The results obtained show that the Mg-Ni treated iron develops nodules of graphite by the decomposition of Fe_3C, instead of the normal flake-forms . Moreover, identical types of nodules form at all the different temperatures of isothermal decomposition (they only differ in number, distribution and in size), unlike the various types of graphite flakes which are dependent on temperatures of decomposition. It is of interest to note that "D" type of distribution of nodules can be obtained, Fig. 20, in contrast to the more usual random distribution.

Quenching Experiments

The results of the experiments already described and in conjunction with the past work in the field of solidification of cast iron allow a basic hypothesis of the mechanism of solidification of cast iron to be stated as follows:—

The eutectic phase of a hypo-eutectic cast iron begins to freeze as ledeburite *i.e.* an $Fe\delta/Fe_3C$ eutectic mixture. What happens to this mixture subsequently is essentially a question of the stability of Fe_3C (chiefly governed by the composition of the iron) and the time of cooling occupied mainly during the solidification, and partly immediately after, solidification. Thus, if the solidification time in a given mould is equal to "a," (Fig. 3, and the stability time of Fe_3C is "b2," so that $b2 > a$, then the iron will remain "white" or ledeburitic to room temperature. For the condition on the other hand where $a < b1$, the iron will be grey and when $a = b$ the iron is mottled. This hypothesis was used to plan subsequent quenching experiments bearing in mind also the following arguments: When a sample of cast iron is rapidly quenched at a given time during the eutectic arrest, then the part of the eutectic structure which was solid before the quench can be distinguished microscopically from the part which solidified during the quench, the latter being normally a very fine ledeburite. In the case of white iron, *i.e.* where $b2 > a$, the pre-quench ledeburite is normally coarser than the quench ledeburite (but the cooling conditions as well as the iron composition are critical in this case and differences between two ledeburites are not necessarily always obtained). In the case of a grey iron, *i.e.* when $a < b1$, the pre-quench eutectic is grey and the quenched part is ledeburitic. However, the pre-quenched part may have been white prior to quenching and, because of the compositional instability of Fe_3C, be already broken into Fe— and graphite. Clearly, the quenching experiment in such a case is inconclusive as to the previous

history of the prequenched structure. The most suitable iron for quenching experiments is that where a=b, because the point at the end of solidification can be used as the critical point for quenching. When such an iron is quenched at the end of solidification it will show a partly grey and partly white eutectic. If, then, quenching is taken at different times after the end of solidification these samples will show progressively less and less ledeburite, so that the iron will be completely grey at room temperature. In other words, the residual quantity of ledeburite transforms fully after the completion of solidification at temperatures close to, but below the eutectic arrest.

To verify this hypothesis the following experiments were carried out. The irons used were the same as those which were previously used for the kinetic studies, and which gave a stability time of Fe_3C at the eutectic temperature permitting the progress of solidification to be readily followed. A crucible size was selected which, in each case, under the experimental conditions of h.f. furnace melting and cooling, gives a solidification time of the order of 60 to 85 sec. A series of samples were quenched into iced-brine at the beginning; during; at the end, and after the eutectic arrest. Some of the corresponding microstructures are shown in Figs. 22 and 23; that shown in Fig. 22 indicates that at the end of solidification there is an appreciable amount of ledeburite which almost fully decomposes after the solidification (Fig. 23). The evidence for the breakdown of Fe_3C during and after the solidification obtained in these experiments, depends on the assumption that at the end of the thermal arrest, as indicated by the cooling curve, there is no residual liquid, which may give rise to ledeburite upon quenching. The physical interpretation of the horizontal portion of the eutectic arrest on the cooling curve is that the mould is absorbing a quantity of heat which is equal to the heat of fusion of solidified samples in a given time. At the end of solidification, there may not be sufficient solid formed to keep such a heat balance and there may be still some liquid present at the end of the horizontal portion on the cooling curve. In order to check upon this possibility, an iron which is fully grey (*i.e.* bl $\geq$ a) was quenched at the end of the eutectic arrest. It was found that in this case some ledeburite was present up to 10 deg. C. below the eutectic arrest; this shows that under experimental conditions, the true end of solidification occurs somewhat below the horizontal portion on the cooling curve. However, in the case of the previous experiments with the mottled iron, *i.e.* where a = b, the ledeburite structure disappears at temperatures 25 to 40 deg. C. below the true end of solidification. As the thermal conditions of cooling the sample were identical in both of these experiments, the evidence obtained shows that Fe_3C may decompose during, as well as immediately after solidification.

The correlation between the stability period of Fe_3C and solidification time of a casting can be also seen from Figs. 12, 13 and 14. If the decomposition curve is extrapolated to intersect the horizontal part on the cooling curve, then in those cases where the extrapolated intercept gives a shorter time than the solidification time, the structure of the casting is grey.

(To be continued)

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* The selection given is a very condensed list of papers relevant to the subject treated, but the literature, references 7 and 11, contain a more comprehensive list of papers on the subject of graphite formation in cast irons.

Two Scottish Power Contracts

Subsequent to the completion of the contracts for the construction of 24 miles of tunnels for the Glen Morriston and Breadalbane hydro-electric schemes, undertaken by the Mitchell Engineering Company, Limited, Peterborough, the North of Scotland Hydro-Electric Board and the South of Scotland Electricity Board have awarded a further two contracts to the company.

The first contract, valued at £2,500,000, was awarded by the North of Scotland Hydro-Electric Board for the construction of over 13 miles of tunnels on the Killin section of the Breadalbane scheme in Perthshire. Responsibility for the construction of pipeline aquaduct sections totalling eight miles, the laying of access roads, and the construction of associated intake weirs and shafts will also be undertaken by the company.

The second contract, worth £1,250,000, was awarded by the South of Scotland Electricity Board for work on the new generating station at Kincardine (Fifeshire). The station is due for completion in about three and a half years.

Merger of Nuclear Instrument Companies

The merger is announced of two nuclear instrumentation companies, Isotope Developments, Limited, of London and Aldermaston, and R. A. Stephen & Company, Limited, of Mitcham. Among companies holding interests in Isotope Developments are Associated Electrical Industries, Limited, and Guest Keen & Nettlefolds, Limited.

Mr. W. W. Hill-Wood, chairman of Isotope Developments, has become chairman of R. A. Stephen & Company, the board of which has been joined by Mr. H. A. Luss and Mr. G. A. Thick (joint managing directors of Isotope Developments). The company's policy will not be altered, but the amalgamation will greatly extend R. A. Stephen & Company's facilities for manufacture, research, and development.

A COMPOSITE stand of over 1,000 sq. ft. is being organized by the Gauge and Tool Makers' Association at this year's British Industries Fair to be held at Castle Bromwich, Birmingham, from May 6 to 17.

Foundry Developments in India

Extensions at the Kulti Works of the Indian Iron & Steel Company

Already, the foundries of the Indian Iron & Steel Company, at Kulti in West Bengal (about 140 miles from Calcutta), are amongst the largest if not the largest in India, and since the war continuous modernization has been carried through. The latest development scheme at present in progress at the Kulti works includes the construction of a new foundry for producing small standard pipe "specials" on a mechanized basis. It is hoped that this major scheme (shown in Fig. 1 (below)) will be brought into operation within the course of the next 12 to 18 months.

The existing foundries at Kulti, which is about 11 miles distant from the important railway junction of Asansol, comprise large separate shops for the production of spun pipes, large pipes and "specials," cast-iron railway sleepers, general (heavy) castings and light-iron castings—in addition to a non-ferrous foundry, patternshop, etc. Fig. 2 (right) shows one of the first of a series of marine diesel engines—now being manufactured on a commercial scale in India—the major castings of which are being made in the Kulti foundries.

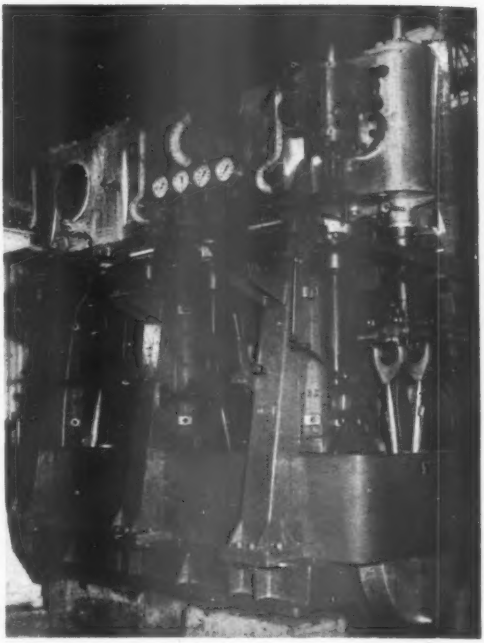


FIG. 1 (*below*).—*General view of the reconstruction in progress at the "pipe-specials" foundry of Indian Iron & Steel Company at Kulti, West Bengal.* FIG. 2 *shows the first of a series of marine diesel engines produced by the Hoogly Docking & Engineering Company, Limited, for the S.T. Bali.*

International Foundry Congress

Preliminary Details of Arrangements made by Scandinavian Hosts

Foundrymen from all countries of the world are cordially invited to attend the 24th International Foundry Congress which the International Committee of Foundry Technical Associations has entrusted the four Scandinavian countries to organize. The Congress will take place in Stockholm, the capital of Sweden, in the third week of August (beginning August 19) this year; the organization being handled by *Sveriges Mekanförbund* (Swedish Foundry Association) in close collaboration with the foundry associations of Denmark, Finland and Norway. The participants in the Congress are invited to visit foundries in all the four countries after the Congress—the organizing countries are pleased to record this manifestation of inter-Scandinavian solidarity within the larger orbit of international co-operation. Many of the Scandinavian foundries are highly mechanized and use advanced methods, and no doubt will prove of great interest to visitors, in addition to the natural scenic, cultural and social amenities.

Headquarters of the Congress

The Houses of Parliament (*Riksdagshuset*), situated in the centre of Stockholm, is to be the headquarters of the Congress. The opening and closing ceremonies will be held there, as well as all the technical sessions and meetings of the International Committees. It will also house the information office. Buses for some of the works visits and items on the ladies' programme will leave from in front of the Houses of Parliament, where parking arrangements are also available.

Official Languages

The " official " languages at the Congress will be English, French and German; the languages of the four Northern countries will not be used for official purposes. Simultaneous translation at the technical sessions will make it possible to follow the proceedings in either of the " official " languages.

Registration

Those wishing to take part in the Congress are requested to register not later than April 15. Registration forms should be completed and addressed *direct* to the Congress Secretariat, *Sveriges Mekanförbund*, Karlavägen 43, Stockholm Ö, Sweden, *or to secretaries organizing block bookings*. On receipt of the registration form and remittance of fees, a Registration Card will be issued by the secretariat—if the Registration Card does not reach the delegate within three weeks, the secretariat should be notified. *Late registration*: Registrations can, if resources permit, be accepted after April 15, 1957. It is, however, *most uncertain* whether hotel accommodation can be arranged in this event. Foundrymen are advised not to go to Stockholm without having booked accommodation in advance, as this is impossible to arrange at the last moment.

Fees

The registration fee is 210 Swedish kronor* for participants in the Congress and 130 Swedish kronor for accompanying ladies. This covers Congress fees, the cost of preprints, the banquet at the Town Hall, sightseeing trips, the Midnight Concert, etc., as well as all the items on the ladies' special programme. Additional charges will be made only for works visits and some special arrangements. Payment is to be effected at the time of registration to *Sveriges Mekanförbund*, Karlavägen 43, Stockholm Ö, Sweden. (Swedish participants to *postgirokonto* No. 51456.) Participants who are prevented at a later date from going to the Congress will have one half of the fees refunded if the secretariat be notified before August 1—no refund can be made after that date. If hotel accommodation has been booked through the secretariat, cancellation charges will be deducted.

Information Office

An information office for the convenience of foundrymen and their ladies will be established at the Houses of Parliament, comprising a congress bureau, a travel bureau, bank, newspaper kiosk, etc. The bureau will be open on Sunday, August 18, between noon and 7 p.m. and thereafter daily between 8.30 a.m. and 6 p.m. to Saturday, August 24 inclusive. Information before and after these dates may be obtained from the Congress secretariat. On arrival in Stockholm, participants are requested to apply as soon as possible to the information office, where they will receive the tickets, badge, etc. AB Nordisk Resebureau, Stureplan 6, Stockholm, is in charge of the official travel bureau which will be located at the information office. They will be responsible for the allocation of hotel rooms, and will furnish all kinds of information regarding tourist trips, sightseeing tours, etc., not included in the Congress programme. Participants will be provided with pamphlets containing practical information concerning communications, hotels, restaurants, etc.

Hotel Accommodation

Those who require the co-operation of the Congress secretariat for arranging hotel accommodation should state exact requirements on the registration form. As only a limited number of single rooms are available, it will be appreciated if participants will double up as far as possible.

For readers who do not participate in the Congress it is possible to order the preprints of the papers only. The price of a complete set will be 40 Swedish kronor if the order (accompanied by a remittance) is sent before June 1.

* At the current rate of exchange there are 14¼ Swedish Kronor to £1

International Foundry Congress

Congress Programmes

MONDAY, AUGUST 19.

10.15 a.m.—Inauguration ceremony: Welcome and address by the president of the International Committee of Foundry Technical Associations (Dr. A. B. Everest); H.R.H. Prince Bertil has expressed his hope to be able to be present. Grand opening Lecture: "Theory and Experience," by Professor Erik Rudberg, of the Swedish Institute for Metal Research.

2.30 p.m.—Sightseeing in Stockholm, either by boat or by bus. (The international dictionary committee and the international committee on foundry defects will meet in the afternoon.)

7.15 p.m.—"Skansen-evening."—An informal "get-together-evening" has been arranged for participants and their ladies at Skansen, Stockholm's famous open-air museum and park; dinner will follow a programme of folk dances and folk songs.

TUESDAY, AUGUST 20.

Works visits Nos. 1 to 7 (see later); evening free.

WEDNESDAY, AUGUST 21.

9 a.m.—Noon and 2 p.m.—5 p.m.—Technical sessions in two rooms simultaneously (meeting of the international committee for the testing of cast iron).

7.30 p.m.—Banquet at the Stockholm town hall (dinner jacket or dark suit).

THURSDAY, AUGUST 22.

Works visits Nos. 8 to 12 (see later). (Meetings of the past-presidents' committee and the International Committee of Foundry Technical Associations.) Evening free.

FRIDAY, AUGUST 23.

9 a.m.—Noon and 2—4 p.m.—Technical sessions in two rooms simultaneously.

4.30 p.m.—Official closing ceremony; addresses by the presidents of the Congress and of the International Committee, and presentation of the Olivo Prize.

9.30—10.30 p.m.—Midnight concert at the National Museum; Scandinavian music; opportunity to see the National art collections.

SATURDAY, AUGUST 24.

10 a.m.—Excursion by steamer on Lake Mälar; visit to Björkö, on which is the site of the town Birka, which flourished as a most famous commercial centre during Viking times, more than 1,000 years ago; picnic luncheon; return to Stockholm at about 4 p.m.

Ladies' Programme

The general programme contains many items which are common both for the gentlemen and the ladies, but some special arrangements for the ladies are as follow:

TUESDAY, AUGUST 20.

The ladies are invited to take part in the excursions to the provinces and to Finland. While their menfolk are visiting foundries, the ladies take part in special programmes in each locality which will comprise visits to social institutions, factories, castles, tourist attractions, etc. Luncheon is included; the return journey will be made in combined parties.

WEDNESDAY, AUGUST 21.

9 a.m.—3 p.m.—Sightseeing: Drottningholm, the summer residence of the Royal Family, with its unique 18th-century theatre. Vällingby, the ultra-modern residential suburb of Stockholm, with its special social welfare services and shopping centre. Luncheon at the Vällingehus restaurant.

THURSDAY, AUGUST 22.

Ladies may again take part in the excursions to the provinces where the arrangements will be similar to those on the Tuesday. For those ladies who prefer to stay in Stockholm, the following programme has been arranged: 11 a.m. —1 p.m.—Visit to the Association for Swedish Handicrafts, in Djurgården, where a school for art needlework and weaving as well as an exhibition of traditional and modern Swedish homecrafts may be seen.

FRIDAY, AUGUST 23.

10 a.m.—2.30 p.m.—Sightseeing and Fashion display: Visits to the big Stockholm natural park, "Djurgården," Waldemarsudde, the home and art collection of Sweden's "Painter Prince" Eugen, and "Millesgården" on the island of Lidingö where the renowned Swedish sculptor Carl Milles has assembled an exhibition of sculpture. Luncheon and fashion display at Foresta restaurant.

Papers*

Preprints of the Congress papers will be available in English, French or German according to the language in which they have originally been written and all exchange papers will bear summaries in the three languages. Efforts will be made to despatch most of the preprints to participants before the Congress.

Country of Origin.	Title and Author.
AUSTRIA	"New Methods for Estimating Tensile Strength, Saturation Value, Graphite Form and Size Ultrasonically," by R. Ziegler (Vienna).
BELGIUM ..	"Zones of Influence of Feeding Head. Possible Feeding Distances and Action Factors," by R. Namur (Herstal).
CZECHOSLOVAKIA	"Theory of the Chemical Hardening of Sand in the CO_2 Process," by Dr. L. Petrzela (Brno).
DENMARK ..	"Metal Penetration into Sand Cores," by K. Fursund (Copenhagen).
UK	"Properties Revealed by Tensile Tests on Pearlitic Nodular Cast-iron," by G. N. J. Gilbert and K. B. Palmer (British Cast Iron Research Association). "Application of Sodium Silicates for Bonding Sands," by F. W. Nield and Dr. D. Epstein.
FINLAND ..	"Notes on the Melting Process and Material Balance in a Hot-blast Cupola," by S. Forsell (Karkkila)
FRANCE	"Application of Gas in Foundries," by A. Portevin (Paris). Further papers have been promised, as yet, without titles being quoted.
GERMANY ..	Titles not yet stated.
HOLLAND ..	"Ageing of Casting Alloys of Aluminium and Magnesium," by L. J. G. van Ewijk (Vaassen).
ITALY	"Air Purification in the Foundry," by A. Riggi (Turin).

* List still incomplete at time of going to press.

Country of Origin.	Title and Author.
JAPAN	" Oxidation of Molten Cast-iron " (with film), by Dr. N. Kayama and K. Nozaki (Tokio).
POLAND	" Theory of Carbon Pick-up in the Cupola," by R. Krzeszewski (Cracow).
SPAIN	" Pearlitic Grey Iron," by J. N. Alcacer and L. F. Carlos (Madrid).
SWEDEN	" Health Hazards in Foundries and their Prevention " (with special regard to silicosis, carbon-monoxide poisoning and heat effects), by Prof. A. Ahlmark and H. Ohlman (Swedish Institute of Public Health, Stockholm).
	" Ventilation in Swedish Foundries," by K. Nilsson (vice-president, AB Svenska Fläktfabriken, Stockholm).
	" Metallurgical Aspects of Hot-tearing in Cast Steel," by K. Beckius (Jernkontoret, Stockholm).
	" Silicon Variation in Cast Iron Melted in Cupolas," by J. Drachmann (Nyköping).
	" Influence of Shape, Surface and Size-distribution of Sand Grains in Moulding Sands," by H. Pettersson (Swedish Institute for Metal Research, Stockholm).
	" Stages in the Development of High-duty Malleable Cast-iron," by B. Thyberg (Husqvarna Vapenfabriks AB, Huskvarna).
	" Variation in Strength of Light-alloy Castings," by F. H. Turner (SAAB, Linköping).
USA	Titles not yet stated.

Works Visits

Many of the foundries to be visited during the Congress are some distance from Stockholm and special trains will, therefore, be largely used; in some cases the journey will be continued by bus. Foundries in the vicinity of Stockholm will be visited by bus. Some data concerning the foundries are given in what follows. In many cases visitors will be shown also other departments of the company concerned, as well as local tourist attractions. Charges include the cost of fares, descriptive literature and luncheon (which in general will be organized by kind co-operation of the companies concerned). The times stated below are only provisional; definite times will be given in the final programme to be distributed to participants on arrival in Stockholm.

TUESDAY, AUGUST 20

(1) *Finland* 8.30 a.m.–8.30 p.m.—Flight to Helsinki (Finland) by chartered planes; visit to Högfors Bruk, Karkkila, which is one of the biggest foundries in Scandinavia with an annual production of 18,000 tons* of iron castings and 400 tons of light metal castings (boiling pans and sanitary ware); highly mechanized; hot-blast cupola. Sight-seeing in Helsinki; luncheon and dinner included. Special programme for ladies. (This tour will be arranged only if a sufficient number of participants are interested); price: 8w.Crs.200 per person.

(2) *Asea, Västerås* 8.30 a.m.–6 p.m.—Special train to Västeras. The foundries of Asea annually produce 10,000 tons of iron castings and 400 tons of cast copper-base alloys and light metals, mainly items for electrical machinery and equipment, steam turbines, etc. Modern, highly-mechanized foundries; induction furnaces for the melting of cast iron and non-ferrous metals; the machine shops may also be visited. (The ladies' programme will probably include a trip by boat.)

(3) *AB Kanthal, Hallstahammar* 8.30 a.m.–6 p.m.—By special train to Västeras, then by bus. Modern steel foundry, producing 1,200 tons per year of thin-walled machinery castings, turbine castings and heat-resisting castings. The principal product of the company is the resistance material " Kanthal."

(4) *Kohlsva Jernverks AB, Kolsva* 8.30 a.m.–6 p.m.—Special train to Västeras, then by bus. Steel foundry, 3,500 tons per year, principally of heavy and light machinery castings, and also cast austenitic manganese-steel (limited number of visitors).

(5) *AB Separator, Tullinge* 9.30 a.m.–3 p.m.—Half-day excursion by bus. Modern iron foundry for 4,000 tons of machine castings and thin-walled castings per year. Melting in hot-blast cupola and 6-ton low-frequency furnace. Modern machine shop, equipped with many special machines, may also be visited.

(6) *AB W. Dan Bergman and Svenska Centrifug AB, Södertälje* 9 a.m.–5 p.m.—(Excursion by bus.) AB W. Dan Bergman is a light-metal foundry with an annual production of 600 tons of sand castings and 250 tons of gravity and pressure-die-castings; intricate castings for machinery in weights of up to 23 cwt.; electric melting furnaces and an automatic moulding unit. Svenska Centrifug AB has a foundry for sand-moulded copper-base alloys, mainly for separators, 400 tons a year; melting in electric-induction furnaces; modern ventilation,

(7) *AB Centrifugalrör, Oxelosund* 9 a.m.–6 p.m.—(Excursion by bus.) Pipe foundry with a production of 25,000 tons a year of centrifugally-cast pressure-pipes and soil pipes; melting in hot-blast cupolas and low-frequency furnaces.

THURSDAY, AUGUST 22

(8) *AB Svenska Kullagerfabriken (SKF) and AB Pump-Separators Gjuterier, Katrineholm* 8.30 a.m.–6 p.m.—Special train to Katrineholm. SKF is a large and modern foundry with an annual production of 14,000 tons of iron castings, 700 tons of spheroidal-graphite iron castings, and 2,000 tons of steel castings; mainly machinery castings, motor castings and axle-boxes. AB Pump-Separators Gjuterier is an iron foundry with a production of 3,000 tons per year, mainly of motor and machinery castings and thin-walled castings, such as piano frames.

(9) *AB Järnförädling, Hälleforsnäs* 8.30 a.m.–6 p.m.—By special train to Katrineholm and then by bus. AB Järnförädling is the biggest malleable-iron foundry in Sweden, mainly producing fittings and machinery castings; mechanized moulding department; modern melting shop with hot-blast cupola/reverberatory furnace (limited number of visitors).

(10) *AB Bolinder-Munktell, Eskilstuna* 8.20 a.m.–6 p.m.—By special train or bus to Eskilstuna. Mechanized iron foundry; motor and tractor castings; 9,000 tons per year; hot-blast cupolas.

(11) *Bröderna Söderbergs Metallgjuteri, Eskilstuna* 8.20 a.m.–6 p.m.—By special train or bus to Eskilstuna. Jobbing foundry for high-quality copper-base alloys and light-metal castings. Sand castings and gravity-die-castings; annual production 1,000 tons.

(12) *AB Åkers Styckebruk, Åkers Styckebruk* 8.20 a.m.–6 p.m.—Special train or bus. Modern foundry producing 5,000 tons of cast-iron rolls and 15,000 tons of soil-pipes yearly. Pipes are centrifugally cast by a special method developed by the company; rolls are cast in grey iron and s.-g. iron in weights of up to 25 tons; melting in four high-frequency furnaces with capacities of up to 8 tons and in a hot-blast cupola; (limited number of visitors).

Post-Congress Visits and Excursions

Post-congress tours of the traditional type will not be arranged after this Congress, as the majority of the participants probably come to Scandinavia by car or by air and will not, therefore, be inclined to take part in pre-arranged tours by train. Excellent possibilities are available, however, for arranging combined study and holiday tours on delegates' own initiative. The Congress committee has, therefore, restricted itself to the following:

(*a*) Agreements will be made with a large number of foundries in Sweden, Denmark and Norway to receive at fixed hours those participants who have announced their intentions in advance. Thus the foundries in the middle of Sweden will be open on Monday, August 26, 10 a.m.—Noon and 2—4 p.m. and at the same hours on the following day. In the middle of the week, foundries in the vicinity of Oslo, in southern Sweden and in the Copenhagen district will be open. At the end of the week, visits can be paid to the foundries in other parts of Norway and Denmark.

(*b*) Receptions of the foreign guests will be arranged in Oslo and Copenhagen in the middle of the week after the Congress.

(*c*) A certain amount of general tourist information and details concerning the main roads in Scandinavia will be provided, but the Congress committee cannot undertake to arrange individual trips, hotel accommodation etc. This should be handled by the participant through a travel agency; the official travel bureau, AB Nordisk Resebureau, Stureplan 6, Stockholm Ö, is prepared to assist.

Detailed information regarding those works visits and other post-congress arrangements will be given in a pamphlet to be issued to all the participants after registration.

(*Continued at foot of page* 282)

* Metric tons, of approximately 2,200 lb., are quoted throughout.

Old Bell Metal

By C. J. Robb.

The history of bell metal commences in ancient Chinese metallurgy, the first reference to this range of alloys is contained in an undated manuscript entitled "K'ao Kung chi." Mention is made of an alloy of 5 parts of copper to one of tin, the metals being melted with charcoal and poured in a "very liquid state" in moulds of glazed porcelain clay. White copper/tin alloys of unknown composition, is also mentioned.

In our early bell-founding industry, established in the 1300's we find mentions of alloys of 9 parts copper to 3 of tin, the resulting alloy contained many trace elements, silver being the principal impurity. It was thought that the silver enhanced the mechanical properties and the tone of the products, whereas it is now known that it is detrimental. In later years antimony was added to render the bell metal "hard and sharp"; the old York Minister, Old Tom of Lincoln and Bow Bells all contain this addition. Lord Grimthorpe the "father" of the Big Ben advocated 13 lb. of copper to 4 lb. of tin for large bells, Lord Rosse confirmed this, and was of the opinion that the bell-founders success lay in the fluidity of the molten-metal. The alloys of copper and tin* are still the standard for the sweetest of the founders' arts.

* A usual composition employed to-day is 77 per cent. copper and 33 per cent. tin, and is used for casting bells of all types—Editor.

Vickers-Armstrongs (Tractors)

Change of name of Vickers-Armstrongs (Earth-movers), Limited, to Vickers-Armstrongs (Tractors), Limited, is announced by Vickers, Limited. The change was registered on February 5.

The aircraft, engineering, and shipbuilding businesses of Vickers-Armstrongs, Limited, were transferred to three new operating companies in 1955. Vickers-Armstrongs (Earth-movers), Limited, was formed at the same time, but the relative business was not transferred. It is now considered appropriate to separate the tractor business from Vickers-Armstrongs (Engineers), and the necessary formalities will probably be completed by the middle of the year. Arrangements for more direct contact between overseas dealers and tractor manufacturers are being worked out.

International Foundry Congress

(*Continued from page* 281)

Visit to Finland

The Finnish Association—*Finlands Metallindustriförening-Suomen Metalliteollisuusyhdistys*—will arrange a post-congress tour to Finland. The participants are to leave Stockholm for Helsinki by plane on Saturday, August 21. The next day will be spent by sightseeing in the neighbourhood of Tampere. On Monday, the steel foundry of Lokomo OY, Tampere, is to be visited; that evening the participants are invited to a reception in Helsinki. On the Tuesday, Högfors Bruk at Karkkila is to be visited and then the tour will end in Helsinki. This tour is arranged by Finland's Metallindustriförening direct, without assistance of travel agencies. Further information will be given in the pamphlet mentioned earlier.

Graduates in Industry

At the meeting of the Yorkshire section of the Institute of Fuel on February 13, Commander L. J. F. Howard-Mercer, education and training officer of John Thompson, Limited, expressed the opinion that while some graduates entering industry were first class, others took a long time to fit in. Also there were some who thought they were on a higher plane than others in industry and the result was a bad name for graduates as a whole. Their basic attitude to the job was often wrong, said Commander Howerd-Mercer, they were inclined to consider, erroneously, that manual work of any kind was beneath them. In fact, it was an essential part of training. There were some graduates who were inclined to feel, after superficial experience in one shop or particular process, that they knew everything—training could not be finished in a few weeks or months. Bad time-keeping was another point referred to, and the fact that graduates were inclined not to mix and to form cliques, which was a bad thing. They should take the opportunity of mixing with every group of men right through industry, if they could, as later on they would be expected to be in control of the men.

Referring to foremen, Commander Howard-Mercer said that at first they were inclined to fear that graduates would either replace them or retard their promotion prospects, but he assured them that this was not the case. He concluded by saying that if the graduate realized that he was entering a team and was prepared to play his part, and get down to the job, industry was willing to offer him a training, and he thought that a very fine career could be provided in industry for that type of graduate.

Iron Ore Imports

The appended table shows the tonnage and value of iron-ore imports in January, 1957, and gives comparative figures for January, 1956.

From	Month ended January 31.		Month ended January 31.	
	1956.	1957.	1956.	1957.
	Tons.	Tons.	£	£
Sierra Leone	66,230	34,580	382,644	208,566
Canada	86,718	93,690	413,537	505,906
Other Commonwealth countries and Eire	1,154	950	3,400	3,800
Sweden	368,591	276,723	2,001,367	1,800,355
Norway	11,745	13,155	59,323	80,197
Western Germany ..	1,470	—	9,555	—
France	55,284	39,184	215,665	158,895
Portugal	5,650	11,720	28,018	62,222
Spain	69,863	102,052	353,023	561,779
Algeria	152,641	139,388	848,847	843,537
French West Africa ..	77,431	44,392	351,770	218,627
Tunisia	88,162	72,080	487,191	447,179
Northern Morocco ..	31,995	9,150	242,040	75,792
Southern Morocco ..	29,375	9,350	125,946	41,958
Liberia	19,920	35,290	142,717	220,911
Brazil	40,255	36,777	299,494	353,068
Other foreign countries	48,458	99,137	278,461	586,245
TOTAL	1,154,942	1,017,618	6,243,018	6,169,037

THE light-castings unions' negotiating committee has been empowered to make recommendations to individual unions for their consideration in the event of a further approach to employers in the light-castings industry for a wage increase being rejected. If a dispute arises the unions' joint committee will reconvene with a view to bringing the claim to a successful conclusion.

The Art of Hand Ramming . . . .

. . . . or Moulds 'through the Looking Glass'?

By "Jaques"

There has been a shortage of resourceful and easily trained applicants for work in the foundries for more than a decade and this scarcity is very noticeable in small moulding shops, where specialized mechanical aids are obviously limited in scope and are mostly confined to the main processes. Thus any encouragement which can be given to those entering upon this type of moulding is a good investment. This article gives a few training hints and, in particular, stresses the usefulness of a glass-sided moulding box for use in demonstrations.

The jobbing type of production, within the capacity and scope of the tackle and personnel in a small foundry, can be an expensive (and in some cases) an almost profitless proposition. Oddment and other types of patterns cannot always be worked on moulding machines because of their shape, length, or peculiarities of design and, obviously, it is most unusual to find available moulding boxes which are "just the fit" for almost any style of pattern sent in by outside customers. These limitations relegate the work into the loose-pattern moulding section, where boxes as near as possible to the required size have to be used. Quite often, blank areas of space in such boxes have to be rammed up and—in the case of the top-half of the moulds—extensively gaggered or grated to ensure a clean lift and a non-drop turnover when closing.

One section of the foundry—as old as the industry and probably one of the most difficult to keep up to the mark—is that dealing with hand-ram, hand-draw, patternplate production. In many small shops, this department, although it may have a better type of moulding box, aluminium patternplates, and a length or two of roller conveyor, demands the same high standard of ability from the personnel as in the past. In this respect, job for job (except for mould jointing and odd-side planning), a first-class semi-skilled plate moulder is not far behind his loose-pattern craftsman colleague. Yet, by the introduction of new methods, it is possible to develop further the hand-rammed, patternplate section and so enable it to take almost any type of split-pattern and hard-set material odd-sides.

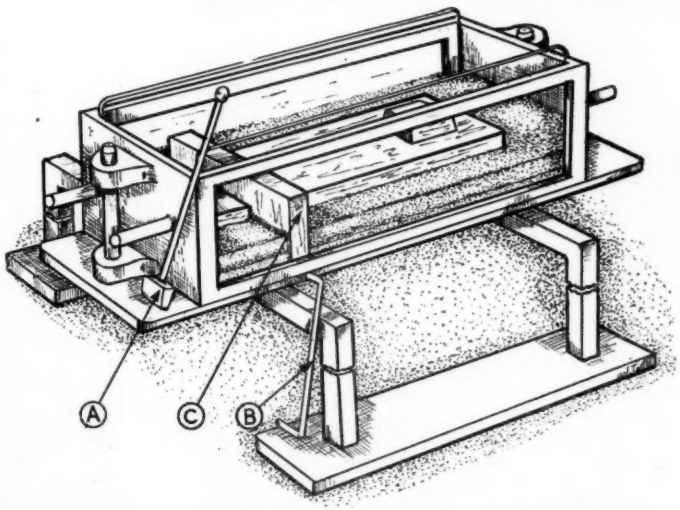


FIG. 1.—*Set-up of a glass-sided moulding box and patternplate for training purposes. One edge of the pattern, C, can make contact with a glass side so as to demonstrate visually the effect of inconsistencies of ramming, etc. At A is shown a suitable design of single-handed rammer and at B, a usual type of gagger rammer recommended by the Author.*

Training Necessary

This article, suggesting general precepts suitable in training personnel for the type of work outlined, is necessarily limited in scope, but the suggestions set out can be applied with advantage in any trainee and beginner section. A day or so spent by employees in this department will provide a sound basis for future working, and will save endless explanation later on as to the cause of many types of waster castings.

Hand ramming, patternplate lifting, on single- and double-ended moulding boxes (in that order), constitute one of the difficult aspects of the moulders' craft to explain and demonstrate to others. The correct density of hand ramming to employ for each course (layer), of sand, can only be achieved by careful tuition and practice; the how-to-ram-evenly-all-over technique has a most important bearing on obtaining consistent weight and quality of castings. Castings exhibiting such

defects as swellings and uneven mould joints, caused as a result of the pouring pressure of the metal on soft-rammed mould areas, are difficult to trim in the fettling shop. "Pregnant eyesores" is the appellation given to them by a facetious grinder. Moreover, perfect lifts and pattern withdrawal depend almost entirely on evenly, hard-rammed outlines and areas, plus the use of a suitable green-bonded sand. There are fewer "mends," discouraging knockouts and drop-offs when these points are watched. With soft-rammed moulds, such faults are expected and looked for. Maybe just a corner falls off as soon as the mould top-part is rolled over, or perhaps other portions are jarred off (and their fall announced by the "looker-under"), during the last few inches of lowering of the top-part on to the cored-up bottom-half of the mould. Patched moulds can seldom be restored to knife-edge outline and symmetrical pattern shape even by the best "moulder-artist," although his tool-box contents may total as many as those in a burglar's kit.

Useful Equipment

Care should be taken in the design of the hand rammers used by beginners—a single-handed short rammer for a trestle job will leave the other hand free for levelling and tucking the sand here and there during the ramming. Fig. 1 (A) shows a suitable type of single-handed "peg rammer," and Fig. 1 (B) is the usual type of gagger rammer.

A useful piece of equipment for school and training class is a double-handed-lift, glass-sided moulding box fitted with detachable sides, shown in Fig. 1. During instruction, for observation and other purposes to be explained later, a typical pattern flange (C), used for training purposes, can be brought flush up to the glass-panel face. Then, worked as shown, the instructor can demonstrate precisely what even "course ramming" means, exactly how to avoid "bruising" of the pattern, and the reason for leaving high sections of the pattern uncovered during the first courses of ramming. These details and the density of the ramming can be clearly seen through the "window" by the trainees. A prolific cause of blind scabs—ramming too close to the pattern face—can also be visibly demonstrated in a practical and readily understood manner.

Other Advantages

Training in the disposition of gaggers and grates—how near they should be placed to the pattern face; the reason for tying gaggers; the use of long gaggers laid crossways in a shallow box; use of the double-ended gagger rammer at the gagger crossings to avoid soft-rammed places around these—all can clearly be demonstrated. Likewise, the importance of correct ramming is more easily explained to, and understood by, beginners when a glass-panelled moulding box is used. For close inspection of the sand courses, the glass panel can be rapped lightly and withdrawn from the box, whereupon a light shake from the parting-powder bag will show up the course joints, and application of the mould-hardness indicator-watch will confirm the variations in ramming density.

"Lifting" Difficulties

Also difficult to inculcate when training is dead-level, double-ended, mould-lifting and patternplate withdrawal. Where a half-pattern is worked loose on a pre-set dowel-and-hole patternplate, and the half pattern is lifted with the mould; it is not so important that two operators shall start together and have identical speed of lifting, but when the pattern is integral with the plate, perfect timing and lifting speed is essential, if a clean lift is to be expected. When double lifting there are few moulders who at one time or other—have not blamed their mates for lifting too fast or too slow, when actually the true explanation is that the one could not anticipate the other's first move. With the the glass-sided box-part, the effect of lop-ended lifting can be watched and explained; as can also the effect of rapping the patternplate to provide a clearance between sand and pattern, prior to the draw-out or lift-off. In all these and many other circumstances, such a training aid is invaluable in saving endless repetition of instructions. Injunctions to trainees to do this, avoid that, or take care not to do the other are so much more forceful when they are reinforced by visual demonstration of just what happens *inside the mould* if the precautions are not adhered to.

First Fall in Steel Consumption for Five Years

Provisional figures given by the Iron and Steel Board estimate consumption of all types of steel in the final quarter of 1956 at 3,341,000 tons, 4.3 per cent. less than for the similar period in 1955 and 7.5 per cent. less than in the first quarter of the year. The change, the board states, appears to be due partly to less steel being used to increase the volume of work in progress in the metal-using industries than a year ago.

Compared with 1955, apparent steel consumption for the four quarters of 1956 diminished from 8.5 per cent. above, to 4.5 per cent. and 0.7 per cent., to 4.3 per cent. below the figure for the previous year. It is the first time for five years that there has been a fall in steel consumption in the UK.

The change is also a reflection of the change in the pattern of consumption. Many of the capital equipment and exporting industries are increasing their use of steel—as is evidenced by the continuing heavy pressure of demand for plates and sections—but consumption in the consumer goods industries, particularly the motor industry, has fallen. There has been a sharp fall in steel imports: those of sheet especially reached some 450,000 tons in 1955, but have now almost ceased.

A further substantial increase in steel stocks held by consumers and merchants, by 210,000 tons in the last quarter, and by 575,000 tons over the whole year, is reported. Stock movements of products such as sheet, plate, and tinplate, varied widely during the year. Sheet stocks held by consumers increased during the first half of the year by 62,000 tons and are estimated to have fallen by 56,000 tons during the half year June-December. Plate stocks are estimated to have increased by about 140,000 tons, the increase for the fourth quarter being about 62,000 tons.

Equipment & Supplies

Vacuum Furnaces

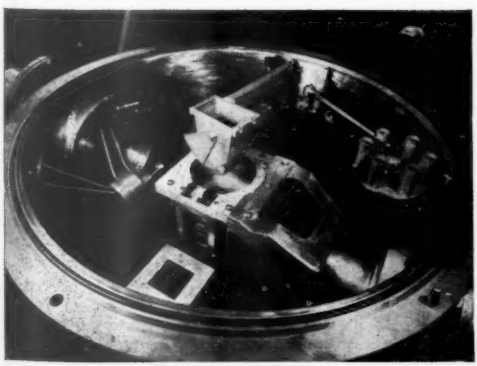
Edwards High Vacuum, Limited, Manor Royal, Crawley, Sussex, are now producing three types of vacuum furnaces, one of which is heated by induction and two by resistance, *viz.*:

Efco-Edwards Furnaces. These are manufactured in two sizes: 28-lb. and 56-lb. capacity, the design originating from the co-operation between Edwards and the Electric Furnace Company, Limited. Operating features claimed for the plant include: The use of high-speed vapour-booster pumps for the rapid removal of gases evolved from the melt, together with a high-capacity air-ballast mechanical pump, and provision for the installation of alternative vapour pumps to increase the pumping rate. Provision of an internal charge feeder having a capacity up to one-third of the total charge, coupled with a small feeder system giving a random choice of six different materials, permits a wide selection of constituents for a melt. There are also an internal poker (for the elimination of "bridges"), a sampling stick and immersion pyrometers; the apparatus is fitted with a spring-loaded safety explosion port. Fig. 1 illustrates the interior view of the furnace unit showing the positioning of the fittings.

Model RH. 40 Resistance-heated furnace. This resistance furnace has been developed for both research and industrial degassing; the heat-treatment of metals; brazing and sintering at temperatures up to 1,500 deg. C. It is claimed that vacuum treatment eliminates the necessity for flux, for instance in brazing, a factor also extending to the melting and heat-treatment of metals prone to oxidation.

Low-capacity Vacuum Casting Furnace. This furnace of ½-lb. capacity, is resistance heated; when casting, the metal passes over a small refractory channel, which bridges the gap between the crucible and the suspended mould, and acts as a splash shield. The furnace can be coupled to a mobile vacuum pumping system comprising vapour and rotary pumps, gauge head and all valving. A power unit of 230 v. of 2.25 kva rating is required, control of the power can be effected by means of a cut-out protected "Variac."

FIG. 1.—*Interior view of the Efco-Edwards high-vacuum melting and pouring furnace showing the internal bulk-feeder swung into position over the crucible, and the internal arrangement of the furnace fittings.*



Rubber-lined Valve

The Wilkinson Rubber Linatex, Limited, of Camberley, Surrey, have introduced a lined, full-bore, straight through valve. Fig. 2 shows a cross section of the equipment in the sealed position. It is claimed that the "Linatex" tube, isolating the metal components, ensures a streamline flow at all positions, and gives a perfect seal, whilst preventing corrosion from chemicals and abrasives. It is suitable for the regulation of abrasive and corrosive slurries; chemicals and vapours. The valve can be fitted with synthetic tubes which are interchangeable with "Linatex" linings, the fitting of these inserts is simple and can be effected "on the spot."

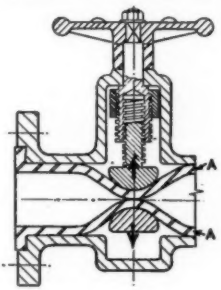


FIG. 2.—*Cross-section of the valve fully closed, showing the position of the sleeve AA.*

Automatic Lubricators

Tecalemit Limited, Plymouth, Devon, manufacturers of lubricating equipment announce that the Bijur range of mechanical pumps is being extended with the introduction of the "M" type cyclic lubricator. This lubricator is designed to give intermittent, measured amounts of oil at pre-determined intervals. It is available with a range of reduction ratios to suit various operating speeds and conditions.

The discharge volume per lubricator operating stroke is adjustable between 2.5 and 5.5 cc. and by choice of the lubricator with the most suitable reduction ratio, it will be possible to provide a total oil discharge of between 0.1 and 20.0 ml. per hour, dependent upon the speed of drive available. The drive itself is rotary and therefore the lubricator may be driven (clockwise or anti-clockwise) by a rotating shaft of any machine on which it is mounted. The lubricator has an average discharge pressure of 40 lb. per sq. in. and the reservoir is of one-pint capacity.

Platinum Progress in South Africa

The full designed rate of production at Rustenburg Platinum Mines (South Africa) is expected to be reached towards the end of 1957, and from about that time onwards platinum arising from the 1956/57 programme will become available for sale in increasing quantities. The cost of the 1956-57 expansion will be about £1,800,000, the greater portion of which will be spent during the financial year ending August, 1957. The cost of the scheme together with the cost of completing the 1955-56 programme and of carrying out other work of a capital nature, such as shaft sinking, will mean that capital expenditure will remain at a high level during the financial years 1957 and 1958, but will lessen considerably during 1959.

Notes from the Branches

South Africa

The January meeting of the South Africa branch of the Institute of British Foundrymen was held in the tea-room of the Witwatersrand Technical College, Johannesburg; this move to a new and commodious lecture hall proved a wise one as the meeting was very well attended and the hall comfortably filled. Under the chairmanship of Mr. G. F. Alexander, branch president, Mr. W. J. C. Ritchie presented a paper entitled: "Design, Construction and Operation of a Water-cooled Cupola" written jointly by Mr. A. P. Alexander and himself. The Authors introduced their paper as follow:—

"The purpose of watercooling was twofold:—(a) Maintenance of uniform diameter of cupola in the melting zone throughout the duration of operation. This removes a variable in melting conditions and assists in the melting of material to uniform specifications. (b) To obviate the use of refractories in the highly eroded melting-zone area, which measure reduces slag formation and cuts refractory and labour costs. The above factors have many consequences, depending upon their specific application. The purpose of this paper is to set out the Authors' experiences and to exclude generalizations. The reason for applying water-cooling in this instance arose out of the necessity for reducing erosion in the melting zone over ten-hour melting periods."

The Authors then related experiences with various designs over a period of some 3 years and summarized their findings as follow:—

(1) For design purposes the heat loss to the water-cooled area can be based on 6,000 B.T.U. per sq. ft. per hour.

(2) A 50 deg. C. temperature differential has proved very satisfactory and it is not considered desirable to exceed this. It should be noted also that this differential is quite independent of water input-temperature. The temperature of the reservoir is of no consequence provided that it is less than the boiling point of water less the maximum temperature differential between segment input and exhaust.

(3) Segments can be designed in many ways, but a system of parallel ducts is considered most desirable so as to avoid excessive frictional heads, reduced flow rates, increased temperature-differentials and steam pocketing.

(4) Automatic interlocking on the water feed is imperative. If the water flow stops during the operating period, the segments are subjected to the full flame temperature, the consequences of which can be readily appreciated.

Discussion

Mr. S. Pienaar opened the discussion by paying tribute to the Authors for their courage and ingenuity in being the first, as far as was known, in South Africa and possibly on that continent to design, construct and successfully operate a water-cooled cupola. He then related and illustrated his own installation of a duplexing plant used in the production of malleable castings. In spite of the fact that their water-cooled cupola had only been in operation for some six months, very little trouble had been experienced during its operation for the production of a metal composition suitable for both high- and low-carbon malleable work.

At the conclusion of Mr. Pienaar's remarks, Mr. Ritchie answered a variety of questions relevant to water cooling. For example, he stated that the same amount of water flowed through the cooling segments when burning in the bed as when the furnace was operating for melting. He also remarked that there was no appreciable lowering of the position of the melting zone due to water cooling.

One questioner suggested that from the paper and subsequent discussion he gathered there was no metallurgical change to be expected, the only change being in the saving of labour and refractory materials. He then queried as to whether or not the expensive electrical installation was justified.

In reply, Mr. Ritchie stated that in his opinion the saving of labour and lining materials coupled with the fact that it was possible to obtain metal of consistent specification and ensure easier cupola operation more than justified the cost involved.

Mr. S. Jane concluded the proceedings by proposing a sincere vote of thanks to the Authors, and this was heartily accorded.

British Standards Institution

Prepared under the authority of BSI's Mechanical Engineering Industry Standards Committee, a new British Standard (B.S. 2831: 1957) applying to methods of testing air filters, has been issued.

Methods

Section two of the standard relates to the "Methyline blue efficiency test." Methylene blue dust used, contains only fine particles, because of this, the test is severe and filters exposed to normal atmospheric impurities would be expected to show higher efficiencies than those indicated by the test results. Nevertheless, the test provides a fair comparison of the relative efficiencies of different filters when used under similar atmospheric conditions. Among the requirements in this section of the standard are those for: The test rig; calculation of results, and the apparatus for the production of test dust. Section three deals with a test for "Dust-holding capacity and gravimetric efficiency." The foreword to the standard points out that atmospheric pollution differs from the standard methylene blue-dust cloud in that it may contain some coarse particles in addition to the fine ones, these larger particles are believed to be mainly responsible for the clogging of a filter, with consequent increase of resistance and termination of its useful life. Resulting from the fact that the life of a filter may be as important as its efficiency, the methylene test is supplemented by a test for dust-holding capacity employing two grades of coarse dust. Among the requirements in this section of the standard are those for: The test rig; ancillary equipment, and reporting results. Both sections of the standard are fully illustrated.

Appendices

The standard has four appendices including one which lays down a specification for esparto paper, and another which provides a worked example of the method of calculating the value of methylene blue efficiency.

Copies of B.S. 2831 may be obtained from the British Standards Institution, British Standards House, Sales Branch, 2, Park Street, London, W.1.

International News

The *Verein Deutscher Giessereifachleute* (German Foundrymen's Association) has nominated Dr. G. Schweitzke as the vice-president of the International Committee of Foundry Technical Associations for 1957. Dr. A. B. Everest is now president of the Committee and will be the chief guest at the International Congress to be held in Stockholm, August 19 to 24. Mr. V. Delport is the honorary treasurer, and Mr. George Lambert, the honorary secretary. The 1958 Congress is to be held in Brussels.

Development of a Disposable-pattern Process for Precision Castings

Application in America of a Special Refractory

What is claimed as a new technique for making precision-casting moulds has resulted from more than two years' development on the part of Corning Glass Works, of Corning, N.Y., and certain metallurgical research foundations. Whilst additional development is still being carried on, the basic elements of the technique, known as the Glascast moulding process, are now fully defined. It is now possible for individual precision foundries to obtain the required materials and apply the process in their own operations.

The process is reported to have a number of outstanding advantages, including low scrap losses. Thus, in a pilot run, casting jet-engine turbine-blades, one manufacturer achieved 90 per cent. acceptable castings. The surface-finish attainable is said to be excellent and the Glascast mould material completely stable: neither expanding nor contracting in curing on heating. The process offers rapid mould-firing, with a maximum of 20 min., and it requires less than one day to proceed from the pattern to the final casting. The Glascast material is also chemically inert and shows less reaction with a greater number of alloys than any other materials currently being used in America. A further advantage is offered by the uniformity of the mould—since it is composed of the same material throughout, there can be no casting rejects because of precoat and investment-body separation or failure. No new equipment has to be purchased to carry out the process: existing foundry facilities are adequate; no special skills are required, operators can be trained in a few hours.

The new process is being made available to all potential users on a licence-free, royalty-free basis. The Glascast material itself is a patented product of the Corning Glass Works. While the process is not patented, applications have been filed on certain items of equipment developed in conjunction with the process; among these is the furnace for "flash-firing" and wax removal.

Wax patterns which are in current use for any of the investment techniques are suitable for the process. A high-gloss pattern with a very smooth surface is preferable in order to take full advantage of the excellent surface reproduction which is possible. For the slip coat, a "slip" of high Glascast-solids : water ratio is prepared, to which are added a colloidal-silica suspension with 35 per cent. solids, Nalcoag* (35), and a water-soluble synthetic gum, Methocel (0-4.000 cps), to improve dipping properties. A common wetting-agent, Aerosol OT, is also added to the slip if it is desired to improve the wetting property.

For the grain coat, dry Glascast grain is dusted on to the wet slip which adheres to the pattern. Wax removal and mould firing may be carried out by placing the pattern and mould assembly directly into a furnace at 1,050 deg. C. for a period of 15 to 20 min., during which time the wax is burned out and the mould is fired. It is desirable to use a furnace with a removable floor so that most of the wax (up to 90 per cent.) can run out free without burning, and can be recovered.

Process Details

To carry out the new process, parting compounds and other impurities are first removed by dipping the pattern in acetone; if it has accumulated surface dirt, it may be washed first in detergent. The pattern is then dipped into the slip, swirling it to remove adhering bubbles; it may be hung up to drain and then to dry. Drying takes about 15 min., but the time varies with circumstances. After drying, the pattern is again dipped as before. While the dip-coat is still wet, a grain coat of 35 to 50 or 50 to 80 mesh Glascast refractory is applied. This may be done in a "rain" or stucco machine or may be applied by simply sifting the grain on the dip coat on the wax pattern. The pattern should be completely and uniformly covered with the grain coat.

The coated pattern is then allowed to dry before re-dipping. This drying will take about ½ hour, again depending on circumstances. Drying can be accelerated if the assembly is placed in a box containing gaseous ammonia. Rapid setting may also be effected by incorporating a small amount of ammonium carbonate with the refractory grain.

The processes detailed in the three previous paragraphs are repeated a sufficient number of times to achieve a workable coating.† Stuccoing on second and subsequent coats may be done with coarser grain (20 to 35, or 14 to 20 mesh) if desired. Six or seven cycles will result in a shell approximately ⅛-in. thick, which should be satisfactory in most instances. The assembly is then allowed to dry at room temperature for a period of eight or more hours—circulation of the air will accelerate drying. An increase in room temperature or drying by the application of heat should be avoided, however, since any temperature increase during drying causes an expansion of the wax pattern and this may result in cracking of the mould.

Firing and Casting

The assembly is then placed directly into a furnace at 1,050 deg. C., where sufficient ventilation must be provided to ensure complete burning of the wax. From 15 to 20 min. at this temperature

* Nalcoag consists of a colloidal silica suspension with 35 per cent solids; Methocel 4.000 cps. is a water-soluble synthetic-gum derived from purified cellulose (it corresponds in chemical composition to the dimethyl ether of cellulose), and Goulac consists of a wood-derived clay substitute.

† In this country, the repeated-dipping process for coating the patterns with refractory has been practised for some considerable time, for example, in the "Investment-X" process.—Editor.

Development of a Disposable-pattern Process

should suffice. After firing, the moulds can be taken directly to the casting operation or may be cooled and stored for later use. Moulds which have been stored should be preheated before casting alloys or metals of high melting points, the approximate preheating requirements being as follow: Aluminium, up to 150 deg. C.; brasses and bronzes, up to 315 deg. C. and stellites, J-alloys, stainless steels, etc., at 815 deg. C. to 1,035 deg. C., all for 15 min. The Glascast moulds will normally crack away from the metal after casting and residual mould material can easily be removed, using simple tools.

Slip Coats

Two formulations are recommended for the preparation of the slip for the first dip coat; as follow:

A 10 formula.	ml. per 100 gm.
Glascast powder, 325 mesh, 97.5 per cent.	
Victoria ball clay, 65 mesh, 2.5 per cent.	
Gum arabic 10 per cent. solution‡	15
Tartaric acid 50 per cent. solution (by weight)	1.5
Nalcoag* 35 per cent.	5
Aerosol OT 75 per cent.	0.15
Water added	8.5 to 9.0

‡ 10 gm. of gum arabic for each 100 ml. of solution.

Formula A10 can be mixed either in a ball mill or with a propeller-type mixer. The slip should then be further mixed for about 12 hours in bottles mounted on rollers. Final minute additions of the wetting agent (Aerosol) may be necessary for final conditioning.

A 15 *Formula* (Based on 100 gm. of powder).

Glascast powder, 325 mesh	100 gm.
Goulac	2 gm.
Tartaric acid, 50 per cent. solution (by weight)	0.6 ml.
Nalcoag 35 per cent.	2.5 ml.
Aerosol OT (75 per cent.)	0.06 ml.
Water (de-ionized)	24.0 ml.

The water and Nalcoag must be premixed and the dry constituents (Glascast and Goulac) added while stirring with a propeller-type mixer. Tartaric acid is then added and a period allowed for the slip to stabilize in viscosity. Aerosol is put in last, using only enough so that a test-piece of wax is properly "wet." The slip must stand for approximately one hour before use; de-aeration is not required with either formula.

Conference on Hydraulics

Recent developments in hydraulic controls and drives will be reviewed at a conference arranged by the British Iron and Steel Research Association, to be held from March 26 to 28, at Ashorne Hill, near Leamington Spa. The chairman will be Mr. W. M. Larke, of Stewarts and Lloyds, Limited. Further information and details can be obtained from the Technical Secretary, Plant Engineering Division, BISRA Laboratories, 140, Battersea Park Road, S.W.11.

Publications Received

Data on Cast Iron—A Handbook for Engineers and Users of Castings. Published by the British Cast Iron Research Association, Alvechurch, Birmingham.

The copy of this book under review was issued for circulation amongst those attending the recent BCIRA conference on the "Engineering Properties and Uses of Iron Castings." It is, in a way, a provisional publication and carries Parts I and II, the former being a general introduction to the subject and moreover a very interesting one. Part II details the mechanical, physical and electrical properties of cast iron; Part III, still to be published, will cover specific service performances such as under wear, corrosion, and high-temperature conditions.

The value of such a complete collection of data such as this is that, completely free of sales talk, the engineer can assess the properties of cast irons in relation to other metals and alloys available to him. Even where cast iron does not measure up to those given by other alloys, it is good business to place such information before the engineer. On the other hand, many of the excellent properties of the range of alloys entering within the generic term "cast iron," are not as well known as they should be. When the engineer "discovers" these in a reference book such as this, he is much more likely to be favourably impressed than when they reach him through one of the many means of advertisement. The great value of this book is unquestionably in Part II where data are set out under 19 headings, and for their assembly the search has been alike prolonged and wide. The reviewer looks forward to seeing the complete book as it is obvious that in Part III cast iron will show up quite well.

National Foundry College—Ninth Annual Report. Issued from the College, Stafford Street, Wolverhampton.

This report should be read by everybody interested in the foundry industry, as in it there is much ground for satisfaction and not a little of which to be proud. The curriculum disclosed is of the type the perusal of which will make most foundry executives regard their industry in a new light. The expected headings—moulding, coremaking, and the like—are not used; instead, foundry technology, management, metallurgy, analyses and projects replace them. These are the very subjects of which the average foundry owner, or executive—if he is honest—will confess that he lacks the essentials. His reaction, on realizing this state of affairs, should be to accord maximum support to the College, by sending an appropriate member of his staff as a student or, alternatively, placing his name on the list as being interested in employing a graduate from the College. Despite the excellence of the training, the numbers of students turned out are in truth totally inadequate to service such a huge industry as ours, especially when it is realized that a high percentage of the students come from overseas and others are sponsored by firms within the industry. The reviewer is satisfied that the type of instruction given is adequate both for the needs of the industry and the student. JOURNAL readers should familiarize themselves with what is being done by writing to the principal of the College for a copy of this report.

M. & C. SWITCHGEAR, LIMITED—Mr. G. K. Talbot, who has been appointed chairman in succession to Dr. J. B. Mavor, is also a director of the parent company, Mavor & Coulson, Limited. Mr. John Stuart has been appointed sales director.

New Patents

(Copies of complete specifications are obtainable from the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery Lane, London, W.C.2, price 3s.)

763,260. Gebr. Bohler & Company, A.G., Elisabethstrasse, 12, Vienna, 1, Austria.

A method of casting metals with an electromagnetic field of force acting upon the melt. A special feature of the invention is that the impulsive movements produced by an impulse-generator are imparted to the melt by the field of force.

763,276. Koji Sudo, No. 139, 4-chome Higashi, Magome-cho, Ota-ku, Tokyo, Japan.

A process for making ductile cast iron. An intimate mixture of pig-, scrap- or cast-iron is formed together with a carbonaceous reducing agent. Slag forming materials are added such that the slag produced contains SiO_2, 45 to 65, Al_2O_3 15 to 20, Ca + MnO + FeO + MgO 20 to 35 per cent. The mixture is then melted at a temperature between 1,400 and 1,500 deg. C. whereby a reaction occurs between the pig-, scrap- or cast-iron and the reducing agent. The FeO content of the resulting product is not more than 0.01 per cent.

763,417. Huttenwerk Oberhausen, A.G., of Oberhausen, Germany.

A method as claimed in Patent No. 726,368 for the refining, by the basic Bessemer process, of phosphorus-containing pig-iron.

763,442. W. T. Bolkcom and W. E. Knapp, trading as American Metallurgical Products Company, Limited, 3600 Forbes Street, Pittsburgh 13, Pennsylvania, USA.

Low-alloy steels and a method of manufacturing them, and particularly low-alloy castings having improved impact properties especially at low temperatures; improved resistance to corrosion, and freedom from hot tears. A typical composition would be carbon 0.1 to 1, manganese 0.2 to 5, silicon 0.1 to 0.75, sulphur 0.0 to 0.75 per cent. The residue from the treatment of the molten metal with 0.025 to 0.5 per cent. rare-earth metals, and the balance of iron with residual impurities are present in ordinary amounts.

763,523. Kuro Kanamori, 36 5-chome Asagaya Suginamiku, Tokyo-to, Japan, and Y.S.K. Kaisha, No. 1 chome, Marunouchi, Chiyoda-ku, Tokyo-to, Japan.

A method for adjusting the composition of the molten pig-iron in the hearth in a shaft furnace. A powdered material (consisting of an iron-alloy, such as ferro-silicon, or ferro-manganese and/or a desulphurizing agent, *e.g.* silico-manganese or calcium silicide or lime) is fed directly into the layer of molten pig-iron through an inclined tuyere.

763,529. Eisenwerke Mulheim Meiderich, A.G., 98 to 100 Friedrich Ebert-strasse, Mulheim/Ruhr, Germany.

A process for the production of high-duty cast iron in which an iron charge is melted with coke in a cupola furnace. At least part of the coke is a synthetic coke of the kind which incorporates at least one treating substance consisting of a finely-divided metal, metal-alloy, or metal carbide. The production of the coke is given in German Patent No. 912,453.

763,531. United States Steel Corporation, 525 William Penn Place, Pittsburg, 30, Penns., USA.

A method for the rapid reduction of sulphur and silicon content of pig-iron, with the object of providing an iron that is more readily handled in existing steel-making processes.

Parliamentary

Iron and Steel Companies: Capital Stock

When MR. HILARY MARQUAND (Lab.) asked the Chancellor of the Exchequer what proportion of the equity and fixed interest bearing capital of iron and steel companies formerly vested in the Iron and Steel Corporation, respectively, had, up to the present, been transferred to private owners, MR. NIGEL BIRCH, Economic Secretary to the Treasury, who replied, said that in view of the changes in the capital structure of many companies it was not possible to answer the question in the form sought. He was sending Mr. Marquand a copy of the third annual report of the agency in which the position was explained in detail.

MR. MARQUAND: "Even if the Financial Secretary cannot give me exactly what I ask for, would it be fair to conclude that after three years of so-called denationalization the Government has handed over control of policy of 75 per cent. of the productive capacity of the steel industry, but has left the nation to hold the baby of fixed interest bearing securities to the extent of something like 75 per cent.? Is it not time that the Government made a considered statement of its policy in regard to the denationalization of the steel industry?"

MR. BIRCH said there had been no change in policy.

There was no reply when MR. MARQUAND asked, if there had been no change in policy, would the Financial Secretary say whether the nation was informed in the elections of 1951 and 1955 that denationalization would mean merely handing over the control of the industry while leaving the fixed interest bearing capital in the hands of the nation.

In a further question, Mr. Marquand asked what directions had been given to the Iron and Steel Holding and Realization Agency to iron and steel companies whose capital stock was held by it as to the amounts of their gross profits which should be reinvested in the industry or held in reserve.

MR. BIRCH said it was the general practice of the agency to allow subsidiary companies to retain the balance of net profits after payment of dividend at the same rate as in 1948.

MR. MARQUAND: "Is this the policy now being followed in Wales? Is the Financial Secretary aware that as a result of what has been going on the greater part of the steel industry in Wales is still the property of the people and that, certainly in Wales, they voted in the two elections of which I have spoken, the people did not give a mandate for the denationalization of iron and steel? May we have a promise that the Government will now stop as far as it has gone and leave the industries of Wales in the hands of the people?"

MR. BIRCH: "Denationalization of steel was decided by Parliament. I do not see that Mr. Marquand's supplementary question has anything to do with his original question."

Scientific Research and Development

Asked by MR. BERNARD BRAINE (Con.) what proportion of the gross national product was spent by Government and by private industry on scientific research and development, excluding market research and capital development, in 1939, 1950, and 1955, MR. ENOCH POWELL, Financial Secretary to the Treasury, said the proportion in 1955 was estimated at about 2 per cent. Between one third and one half of this work was done in Government laboratories and nationalized industries, and a large part of the remainder was financed by the Government. There were no estimates for 1939 and 1950.

News in Brief

A WORLD CONGRESS ON SCIENTIFIC MANAGEMENT is to be held in Paris, from June 24 to 28.

DEVELOPMENTS at the Barrhead factory of Yorkshire Copper Tubes, Limited, include an extension to the works, an office building and a canteen.

FRY'S METAL FOUNDRIES, LIMITED, Glasgow works, has had plans prepared for the erection of a new foundry at London Road, Dalmarnock.

INCORPORATED PLANT ENGINEERS announce that from February 23, their head office will be at 12, The Parade, Solihull, Warwickshire. (Telephone: Solihull 1111.)

VICKERS, LIMITED, announces that the change of name from Vickers-Armstrongs (Earth-movers) Limited, to Vickers-Armstrongs (Tractors) Limited was registered on February 5. An order from the Government of Pakistan for heavy construction tractors and equipment, worth approximately £900,000, has been secured by the firm.

Lt.-Col. L. URWICK, of Urwick, Orr & Partners, Limited, Park Lane, London, W.1, left on the Queen Elizabeth on February 23, for a four-months' tour of the United States.

THE LORD MAYOR OF BIRMINGHAM, Alderman E. W. Apps, paid his annual civic visit to the Mint, Birmingham, on February 21; he saw coins being made for Iraq and British West Africa.

THE THIRTY-FIFTH ANNUAL CORPORATEE MEETING AND ANNUAL DINNER of the Institution of Chemical Engineers will be held at the May Fair Hotel, Berkeley Street, London, W.1 on April 30.

THE UNIVERSITY OF BIRMINGHAM METALLURGICAL SOCIETY held a meeting on February 21, when the speaker was Professor A. J. Murphy on the subject of the "Work of the College of Aeronautics" (of which he is principal).

STELLA LAMP COMPANY, LIMITED, announce that with effect from last Monday the address of their headquarters and administrative offices is 158/160 Shaftesbury Avenue, London, W.C.2 ('phone covent Garden 3031).

WOLVERHAMPTON METAL COMPANY, LIMITED, which broke up the battleship Warspite when it was beached off the Cornish coast, is to present two seats, made of teak taken from the ship, for use in pleasure grounds at Penzance.

NEW PLANT for the electro-chemical deposition of chromium, which can accommodate components up to 15-ft. long, 5-ft. dia., and weighing up to six tons, has just been completed at the Port Glasgow works of Fescol Limited, North Road, London, N.7.

LORD DUDLEY GORDON, chairman of Hadfields, Limited, Sheffield, welcomed two new members to the firm's "The Fifty Club," which is reserved exclusively for those with 50 years' service at the works. They were 66-year-old Harry Bourne and 63-year-old Lawrence E. Keay.

RUBERY OWEN & COMPANY, LIMITED, Darlaston, are to hold, for the first time, an experimental parents' evening for the parents of all the company's employees under the age of 19. There will be a general discussion on the progress the young people are making and members of the personnel department will answer questions from parents.

BRITISH THOMSON-HOUSTON COMPANY, LIMITED, has secured an order valued at over £2,500,000 for the supply of hydro-electric plant for the Belesar and Eume Power Stations of Fuerzas Electricas del Noroeste, S.A. (Fenosa) of Coruna, Spain. For both stations material to be supplied includes water turbines, sub-contracted to Boving & Company, Limited, waterwheel generators, with associated transformers, 220-kv and 132-kv switchgear and power-station switchgear and control gear.

THE INSTITUTE OF COMMERCIAL AND INDUSTRIAL MANAGERS and the Institute of General Managers announce that Mr. John A. Sargrove will on April 16, at 6.30 p.m. for 7 at the Charing Cross Hotel, lecture on "Automation in the Smaller Business." Non-members wishing to attend this meeting should apply for tickets or further particulars to Mr. C. J. Hatter, hon. secretary, London branch ICIM, 38, Chalkhill Road, Wembley Park, Middlesex.

AT A WELL-ATTENDED MEETING at the Attleborough Parish Hall on February 20, residents of Gipsy Lane, Bulkington Lane and Lutterworth Road, Nuneaton, agreed to resist the proposal to erect a foundry on land in Gipsy Lane. Many of those present expressed their views on the proposal of the Town Council to support the appeal of the British Piston Ring Company, Limited, against the decision of the County Council to refuse the firm's application to erect the foundry on the grounds that it infringes the green belt.

Mr. W. D. PUGH, managing director of the English Steel Corporation Limited, Sheffield, states in a review of the firm's work, that at the new works at Tinsley now being constructed, bigger castings will be possible. A capacity of about 500 tons of liquid steel will involve related problems of making, handling, treating and eventual machining. At its present works, the firm is to make castings of nearly 300 tons, which it is claimed will be the largest so far. Most of the steel made by the firm is also processed there and there would have been new records in all departments had not the Suez crisis arisen.

Mr. H. W. SECKER, chairman of Thos. W. Ward Limited, Albion Works, Sheffield, and Mrs. Secker, welcomed nearly 1,000 guests at the annual staff ball at the Cutlers' Hall, Sheffield, on Friday, February 22. Among other directors present were the vice-president, Mr. Geo. Wood the deputy chairman, Mr. F. R. Stagg, and the assistant managing director, Mr. Arnold Carr. The guests included the Mistress Cutler, Lady Roberts: the managing director of the Park Gate Iron and Steel Company, Limited, Mr. C. H. T. Williams, and the managing director of the Laycock Engineering Company, Limited, Mr. S. Walker. The president, Dr. Ashley Ward, was prevented from being present through indisposition.

WHAT IS CLAIMED TO BE THE MOST COMPACT CONVERTER STEEL PLANT in industry to-day, commenced operations last month, when Mr. H. McC. Lawrence, managing director of Drop Forgings, Limited, Germiston, Transvaal, South Africa, pulled the lever to teem the first 3½ tons of steel from a new side-blown Whiting converter. The new plant comprises two 42-in. cupolas with a melting rate of 6 tons per hour, two 3½-ton converters, eight sets of S-plates each consisting of 24-4½ by 4½-in. moulds, and covers a floor space of only 200-ft. long by 26-ft. wide. This plant has been installed for internal consumption to produce mild steel for reinforcing rods and small intricate sections in the 6-in. and 12-in. four-stand, three-high mills, designed, constructed and installed by the engineering workshops of the firm. The principal product of the firm at the moment is forged-steel rivets of which they produce 1½ million per month. At a later stage, the firm intends to produce nickel/chrome steel forged balls for ore crushing in the gold mines.

Personal

Tube Investments, Limited, announces that the Rt. Hon. the LORD CLITHEROE, P.C., has joined the board.

Mr. WILLIAM HUGH ROGERS has been appointed industrial sales manager of British Oxygen Gases, Limited.

Mr. R. M. MALLOCK, works manager, has been co-opted to the board of Allen West & Company, Limited. Limited.

Mr. J. MAIN, and Mr. W. S. LAWSON, and Mr. G. P. BENNETT, have been elected directors of Worthington-Simpson, Limited, Newark, Notts.

Mr. R. S. BLECKLY has been appointed a director of the Lancashire Steel Corporation. Mr. R. H. CLOSE, secretary of the Corporation, has also been appointed a director.

Mr. ROBERT IWEINS, manager of the Ougrée foundry division of the Societé Cockerill—Ougreé, has been elected president of the *Association Technique de Fonderie de Belgique.*

North Eastern Iron Refining Company, Limited, Stillington, Stockton-on-Tees, announce that Mr. JOHN MORAN, the general manager, has recently been appointed a director of the company and the associated company, Stillington Estates, Limited.

Mr. H. MORLEY has been appointed works manager (services) to Samuel Fox & Company, Limited. He will relinquish his present position as work-study officer to the United Steel Companies, Limited, in order to take up his new appointment on April 1.

Mr. E. O. FAULKNER, M.B.E., a director of Richard Thomas & Baldwins, Limited, and Mr. G. H. HOULDEN, C.B.E., a director of Vickers-Armstrongs, Limited, and managing director of Vickers-Armstrongs (Shipbuilders) Limited, have been elected to the board of directors of Vickers, Limited, London, S.W.1.

Mr. G. GORDON DAVIS, formerly works manager, Bradford works, International Harvester Company, Limited, of Great Britain, has been appointed manager of manufacturing for the UK. Succeeding him as works manager at Bradford is Mr. FRANK J. ZMARZLY, who joined the UK company as assistant works manager at Bradford in 1955.

His Grace THE DUKE OF NORTHUMBERLAND has been elected president of the Institute of General Managers, 86 Eccleston Square, London, S.W.1. Vice-presidents are the Rt. Hon. the VISCOUNT COBHAM, T.D., (Governor-General designate of New Zealand), Sir RUPERT DE LA BERE, BART., K.C.V.O., and His Grace the DUKE OF RUTLAND.

Mr. J. L. CLARIDGE, Mr. H. A. DENNE, and Mr. H. MORTIMORE, have been appointed directors of Lincoln Cars. Lord AIREDALE, Sir STANFORD COOPER, and Sir PATRICK HENNESSY recently relinquished their appointments as directors of that company. Mr. Claridge is secretary, Ford Motor Company, Limited, Mr. Denne is director of sales, and Mr. Mortimore, general sales manager.

Mr. P. M. WILLIAMS of the Incandescent Heat Company, Limited, will be visiting the USA from March 8 to 29. He will visit foundries in the vicinity of New York, Chicago and Cleveland, in which Whiting equipment has been installed. In addition, he will visit railroad companies to see Whiting wheel-grinding and train-washing equipment. A total of 15 visits has been arranged.

Mr. K. S. PEACOCK, chairman and managing director of Guest, Keen & Nettlefolds, Limited, has joined the board of the Steel Company of Wales, Limited. Mr. David J. Young, at present secretary and comptroller of the Steel Company of Wales, has also joined the board. Mr. Peacock, who is 55, is also a director of Joseph Sankey & Sons, Limited, United Steel Companies, Limited, and a number of other companies.

The Royal Society of Arts announces that Mr. D. L. MORGAN, a 17-year-old student at the Kingston School of Art, has won a bursary, to the value of £150, in the domestic-electrical-appliances section of the Industrial Art Bursaries Competition, 1956. Mr. D. J. KEEPAX, of the Birmingham College of Arts and Crafts, age 19, has been awarded a similar bursary in the domestic solid-fuel-burning appliances section.

Formerly joint managing director of the metals division of Imperial Chemical Industries, Limited, Dr. MAURICE COOK has been appointed chairman of that division. He is one of the country's leading metallurgists, and since 1950 has been chairman of the Research Board of the British Non-Ferrous Metals Research Association. He was elected to the Council of the Association in 1940, to the Finance and General Purposes Committee in 1942 and, in 1951, was appointed vice-chairman. Dr. Cook is succeeded as joint managing director of the metals division by Mr. ST. J. DE H. ELSTUB, formerly director of the division.

Having reached retirement age, Mr. PARKER HAGUE has retired from active service with, and relinquished his appointments as director of the Mond group of companies, just a fortnight before completing 52 years in the metal industry. Mr. Hague was born in Sheffield on July 12, 1890, and started work in 1905 as office boy in the armour department of Cammell Laird & Company, Limited. In the years that followed he gained various prizes and was awarded an Associateship of Metallurgy by the University of Sheffield in July 1912. When Cammell Laird and Vickers-Armstrong merged their steel interests in 1929 to form the English Steel Corporation, Mr. Hague was transferred to the River Don Works of ESC as chief assistant to Mr. J. H. S. Dickenson (chief metallurgist) and placed in charge of process control and development of ESC. After 25 years in ferrous circles he moved into the non-ferrous industry by joining the Mond Nickel Company, Limited, in 1930, as general manager of the Nickel Refinery at Clydach, Swansea. This proved to be the commencement of 27 years' service with the group. In 1932, he was appointed general manager of operations which entailed control of refining of nickel in South Wales, precious metals in London, and of the activities of Henry Wiggin & Company, Limited. In 1945, Mr. Hague was given a seat on the board of each company; it is these directorships that he has now relinquished. He will not be entirely separated from the foundry industry as he is retaining the chairmanship of the Cronite Foundry Company, Limited, makers of alloy heat- and corrosion-resisting castings.

Obituary

Sir WILLIAM VERDON SMITH, for 27 years (until 1955) chairman of the Bristol Aeroplane Company, Limited, died at his home in Bristol on February 19. He was 80.

Mr. HARRY CURRINGTON, who died recently at the age of 76, was a former transport manager for 45 years of Sheepbridge Company, Limited, Sheepbridge, Chesterfield.

The death is announced of Mr. W. H. ROBERTS at the age of 79. He was one of the founders, in 1909, of the business of Roberts & Morris, ironfounders, Shails Lane, Trowbridge.

Raw Material Markets

Iron and Steel

There is little change in the overall position at the ironfoundries. Production of castings is proceeding steadily, with no heavy pressure for supplies from any trade. Degrees of demand for castings vary from the different trades for which the foundries cater, and some firms are more favourably employed than others. Foundries supplying castings to the motor-car trade continue to suffer from the recession in the industry. Some are compelled to continue a shortened working week and there is some redundancy.

These foundries are taking up reasonably good tonnages of low-phosphorus and hematite pig-irons, and recent demands from some have shown an improvement. This may be due to absorption of stocks and bigger demands for castings from the makers of commercial vehicles and light cars. Machine-tool makers, heavy engineering trades, and others continue to schedule for appreciable quantities of castings which require good tonnages of pig-iron. The foundries are able to acquire the supplies they need without much difficulty from English and Welsh furnaces. Refined iron makers are fairly busy, but have tonnages to spare, some of which is being exported.

Restrictions at home and the fall in exports for light-casting products continue to affect adversely the outputs of the light foundries. There is no appreciable increase in demand for castings from the domestic utensil trade, and the use of other materials in place of cast iron in the building trades reduces their demands below the normal quantities previously taken by them. Pipes and gutters continue in good demand from the light foundries supplying these castings. Only moderate tonnages of high-phosphorus pig-iron are being specified and outputs are ample to cover these requirements. Many inquiries continue to be received from abroad for supplies of this pig-iron. Although some tonnages could be spared, licences are not available.

The foundries are well provided with scrap, and foundry coke is coming forward in sufficient quantities for present needs. Ganister, limestone, and firebricks are available to requirements.

The re-rollers are reasonably well employed, but, apart from small rounds for reinforcing work, pressure for their products from some home trades for small bars is not so heavy. Some export business is on hand and there are outlets abroad for much larger tonnages which could be supplied advantageously by the re-rollers if export licences could be obtained.

Deliveries of billets from home steelworks are maintained at recent levels, but in many instances these are insufficient, particularly in the smaller sized billets and carbon and special quality steels. With the appreciable outputs which the re-rollers have obtained for some time, the usage of billets has exceeded deliveries since the curtailment in imports; stocks have been considerably reduced.

Non-ferrous Metals

Copper is still a dull market in London. Consumer support is lacking and with a small trickle of selling, prices are gently sagging. However, there is a feeling in certain quarters that the present price level is too low and that an upward adjustment in prices can be expected. In America producers and custom smelters are quoting 32 cents a lb. at which level demand is modest. A fair amount of business is taking place in the export market at a split price of 30-30¼ cents a pound. Scrap copper is quietly steady, although the quotation has eased to around 24½ cents, suggesting thereby that the custom smelters will soon lower their price again if the volume of turnover does not noticeably increase.

As in London, some quarters in both Canada and the United States feel that present prices are too low and that demand will soon increase. Moreover, it is believed that the price of 30 cents per lb. can be considered as a floor price as the US Government has entered into contracts with a number of US producers to take their output at this level. Should this eventuate it will result in a much stronger undertone. One interesting item of news comes from the Kennecott Copper Corporation, which has stated that because of a water shortage in Chile its subsidiary, the Braden Copper Company, is cutting back ore production by 9,000 tons a day from 33,000 tons to 24,000 tons. This would mean a decline of approximately 4,000 tons a month in the output of refined copper from 16,000 tons to 12,000 tons a month.

Tin is not very active in either London or New York. In London the easier price trend reflects the lack of consumer support and the good grounds for believing that the supply position will become progressively easier now that Bolivian ore is coming into the country. In New York the quotation has dropped sharply to below the $1.00 per lb. level on the settlement of the dock strike. A fair amount of business is still being transacted in spot supplies. In London stocks of refined tin rose by 13 tons to 488 tons by February 23, and the backwardation is now less than £15 per ton.

There is nothing new to report about the lead or the zinc markets. Both metals are influenced by US Government stockpiling policies. Nevertheless, demand is reasonably steady and it would not require much additional buying to send prices higher. In the United States the lead price remains firm at 16 cents a lb. and that for zinc at 13½ cents per lb. for "Prime Western," East St. Louis.

New Catalogues

Elevators and Skip Hoists. Marco Conveyor & Engineering Company, Limited, Rowin Works, Leytonstone, London, E.11, have just issued a well-illustrated 18-page brochure covering these two items of equipment which are widely used in the foundry industry. The booklet is unquestionably of great practical value, for the specifications included are quite explicit. In several of the illustrations equipment for foundry purposes is shown. The colour scheme used—green—is quite pleasing. The brochure is available to readers on writing to Rowin Works.

Electrostatic Air Filter. The Sturtevant Engineering Company, Limited, Southern House, Cannon Street, London, E.C.4, have just issued as publication No. 7106, the third edition of an important brochure covering the firm's contribution to the problem of the reduction of atmospheric pollution. The plant carries the trade mark "Precipitation" and the principles of its operation, particulars of the efficiency claimed, installation, and a list of plants in operation are given in this 40-page well-illustrated brochure, which is available to readers on writing to the address quoted.

Hoist Trolley. An illustrated pamphlet has been published by Yale & Towne Manufacturing Company, Limited, Wednesfield, Wolverhampton, Staffs; it tabulates dimensions and specifications along with capacity, and illustrates the various types of trolleys available.

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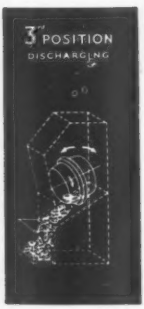

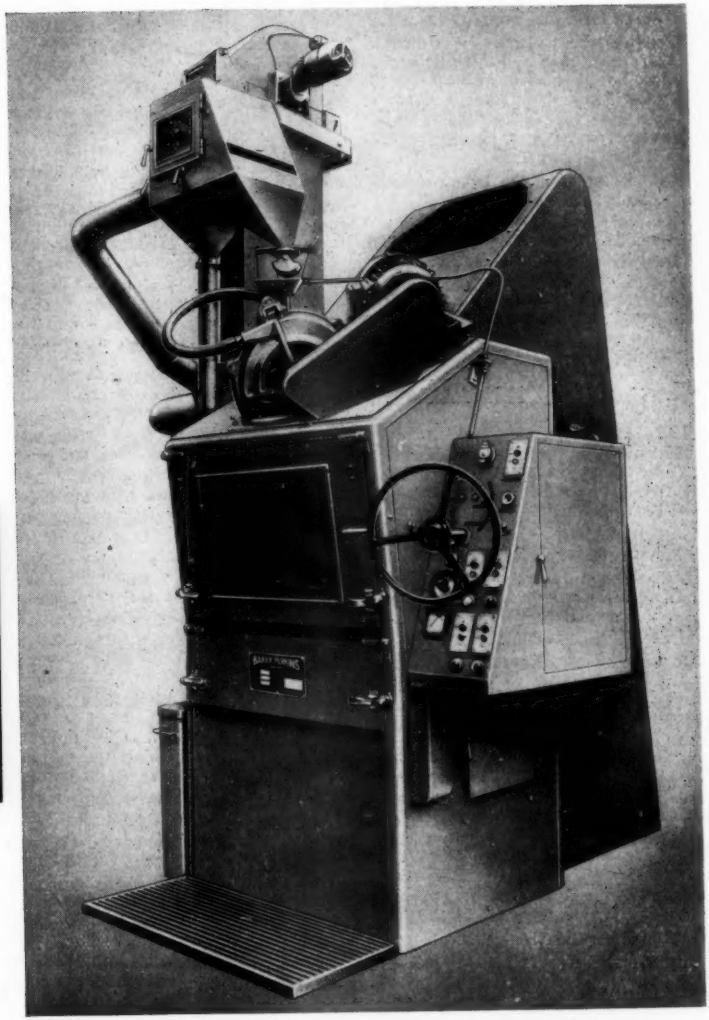

BAKER PERKINS LTD
Engineers
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Current Prices of Iron, Steel, and Non-ferrous Metals

(*Delivered unless otherwise stated*)

February 27, 1957

PIG-IRON

Foundry Iron.—No. 3 IRON, CLASS 2:—Middlesbrough, £20 1s. 0d.; Birmingham, £19 13s. 3d.

Low-phosphorus Iron.—Over 0.10 to 0.75 per cent. P, £21 18s. 0d., delivered Birmingham. Staffordshire blast-furnace low-phosphorus foundry iron (0.10 to 0.50 per cent. P, up to 3 per cent. Si), d/d within 60 miles of Stafford, £22 2s. 3d.

Scotch Iron.—No. 3 foundry, £23 4s. 6d., d/d Grangemouth.

Cylinder and Refined Irons.—North Zone, £24 6s. 6d.; South Zone, £24 9s. 0d.

Refined Malleable.—P, 0.10 per cent. max.—North Zone, £25 14s. 0d.; South Zone, £25 16s. 6d.

Hematite.—Si up to 2 per cent., S. & P. over 0.03 to 0.05 per cent.:—N.-E. of England (local iron), £22 17s. 6d.; Scotland (Scotch iron), Zone S. 1, £23 4s. 0d.; Sheffield, £24 4s. 6d.; Birmingham, £24 12s. 0d.; Wales (Welsh iron), £22 17s. 6d.

Basic Pig-iron.—£19 3s. 0d. all districts.

FERRO-ALLOYS

(*Per ton unless otherwise stated, delivered*)

Ferro-silicon (6-ton lots and over).—45 per cent. Si, £50 0s. 0d. to £51 15s. 0d., scale 17s. 0d. to 17s. 6d. per unit; 75 per cent. Si, £70 0s. 0d. to £75 7s. 6d., scale 17s. 0d. to 17s. 6d. per unit.

Ferro-vanadium.—50/60 per cent., 28s. 6d. per lb. of V.

Ferro-molybdenum.—65/75 per cent., carbon-free, 12s. 3d. per lb. of Mo.

Ferro-titanium.—20/25 per cent., carbon-free, £250 0s. 0d.; 38/40 per cent., £299 0s. 0d.

Ferro-tungsten.—80/85 per cent., 13s. 1d. per lb. of W.

Tungsten Metal Powder.—98/99 per cent., 16s. 1d. per lb. of W.

Ferro-chrome (6-10 ton lots).—4/6 per cent. C, £96 0s.0d. to £96 10s. 0d., basis 60 per cent. Cr, scale 33s. 0d. to 31s. 0d. per unit; over 6 per cent. C, £94 0s. 0d. to £95 10s. 0d., basis 60 per cent. Cr, scale 31s. 0d. per unit; 2 per cent. C,* 2s. 1½d. per lb. Cr.; 1 per cent. C,* 2s. 2d. per lb. Cr; 0.15 per cent. C,* 2s. 2½d. per lb. Cr; 0.10 per cent. C,* 2s. 2¾d. per lb. Cr; 0.06 per cent. C,* 2s. 3d. per lb. Cr.

Metallic Chromium.—98/99 per cent., 7s. 0d. to 7s. 6d. per lb.

Metallic Manganese.—90/92 per cent., carbon-free, £290 0s. 0d.; 96/98 per cent., £310 0s. 0d.

Ferro-columbium.—65/75 per cent. Nb + Ta, 22s. 0d. to 23s. 0d. per lb., Nb + Ta.

Ferro-manganese (home).—78 per cent., £82 12s. 6d.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms, and Slabs.—BASIC: Soft, u.t., £30 9s. 0d.; tested, 0.08 to 0.25 per cent. C, £31 9s. 0d.; hard (0.41 to 0.60 per cent. C), £32 10s. 6d.; silico-manganese, £41 0s. 0d.; free-cutting, £34 13s. 0d. SIEMENS MARTIN ACID: Up to 0.25 per cent. C, £38 4s. 6d.; silico-manganese, £41 7s. 6d.

Billets, Blooms, and Slabs for Forging and Stamping.—Basic, soft, up to 0.25 per cent. C, £36 3s. 6d.; basic, hard, over 0.41 up to 0.60 per cent. C, £37 6s. 0d.; acid, up to 0.25 per cent. C, £40 7s. 6d.

FINISHED STEEL

Heavy Plates and Sections.—Ship plates (N.-E. Coast), £39 2s. 0d.; boiler plates (N.-E. Coast), £41 12s. 0d.; floor plates (N.-E. Coast), £40 11s. 0d.; sectional material, N.-E. Coast, £37 11s. 6d.

Small Bars, Sheets, etc.—Rounds and squares, under 3 in. untested (4-ton lots), £37 18s. 0d.; flats, 5 in. wide and under (4-ton lots), £37 18s. 0d.; hoop and strip, £37 17s. 6d.; uncoated strip mill coils, hot rolled, under 3mm. to 12g., £41 6s. 0d.; black sheets (hand mill), 17/20 g., £52 4s. 6d.; galvanized corrugated sheets, 24 g., £65 9s. 0d.

Alloy Steel Bars.—1 in. dia. and up: Nickel, £64 13s. 9d.; nickel-chrome, £88 15s. 3d.; nickel-chrome-molybdenum, £100 13s. 9d.

NON-FERROUS METALS

Copper.—Cash, £243 0s. 0d. to £243 10s. 0d.; three months, £241 0s. 0d. to £241 10s. 0d.; settlement, £242 10s. 0d.

Copper Tubes, etc.—Solid-drawn tubes, 2s. 4½d. per lb.; rods, 274s. 0d. per cwt. basis; 20 s.w.g., 307s. 3d. per cwt.

Tin.—Cash, £756 0s. 0d. to £758 0s. 0d.; three months, £743 0s. 0d. to £744 0s. 0d.; settlement, £758 0s. 0d.

Lead (Refined Pig).—Second half February, £112 10s. 0d. to £113 0s. 0d.; second half May, £111 15s. 0d. to £112 0s. 0d.

Zinc.—Second half February, £96 15s. 0d. to £97 0s. 0d.; second half May, £94 15s. 0d. to £95 0s. 0d.

Zinc Sheets, etc.—Sheets, 15g. and thicker, all English destinations, £128 0s. 0d.; rolled zinc (boiler plates), all English destinations, £125 15s. 0d.; zinc oxide (Red Seal), d/d buyers' premises, £110.

Brass Tubes, etc.—Solid-drawn tubes, 1s. 11⅝d. per lb.; rods, drawn, 2s. 11d.; sheets to 10 w.g., 212s. 9d. per cwt.; wire, 2s. 8½d.; rolled metal, 212s. 9d. per cwt.

Brass (Brazing).—BS1400, B3 (65/35), £183; B6 (85/15), —; BS249, —.

Brass (High Tensile).—BS1400, HTB1 (30 tons), — ; HTB2 (38 tons), — ; HTB3 (48 tons), —.

Gunmetal.—BS1400, LG2 (85/5/5/5), £247; LG3 (86/7/5/2) £257; G1 (88/10/2/½), £303; (88/10/2/1), — .

Phosphor Bronze.—BS1400, PB1 (AID released), £318 per ton.

Phosphor Bronze Strip, etc.—Strip, 293s. 3d. per cwt.; sheets to 10 w.g., 293s. 3d. per cwt.; wire, 4s. 0½d. per lb.; rods, 3s. 4½d.; tubes, 3s. 4½d.; chill cast bars: solids 3s. 4d., cored 3s. 5d. (CHARLES CLIFFORD, LIMITED).

Nickel Silver, etc.—Rolled metal, 3 in. to 9 in. wide × 0.056, 3s. 10½d. per lb.; round wire, 10g. in coils (10 per cent.), 4s. 3½d.; special quality turning rod, 10 per cent., ½ in. dia., in straight lengths, 4s. 2½d. All prices are net.

Other Metals.—Magnesium, ingots, 2s. 5½d. per lb. Antimony, English, 99 per cent., £210 0s. 0d. Quicksilver, ex-warehouse, £84 10s. 0d. to £84 15s. 0d. Nickel, £600 0s. 0d. Aluminium ingots, £197 0s. 0d.; aluminium bronze (BS1400), AB1, £263; AB2, £272. Solder, brazing, BS1945, type S (50/50), — per lb., type 9 (54/46), — per lb.

* Average 68-70 per cent.

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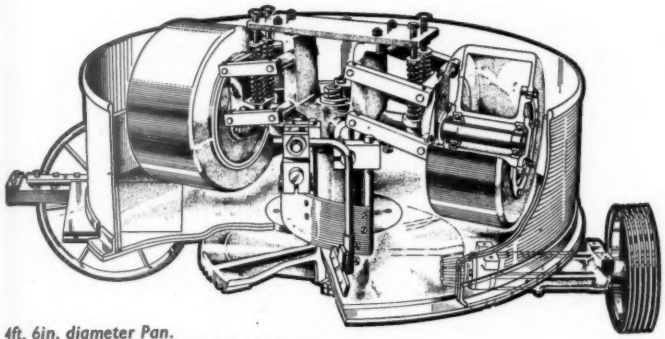

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Company News

HENRY NORRINGTON & SON, LIMITED, agricultural engineers and ironfounders, of Exeter—The dividend is reduced from 20 per cent. to 15 per cent.

FOLLSAIN-WYCLIFFE FOUNDRIES, LIMITED—A final dividend of 10 per cent. makes 17½ per cent. for 1956, against 25 per cent. before the 50 per cent. free scrip issue. Group net profit was £32,341 (£30,353).

KEITH BLACKMAN, LIMITED, mechanical and electrical engineers, etc., of London, N.17—Following the announcement that the company had acquired a controlling interest in the Blackman Export Company, Limited, the latter company has now become a wholly-owned subsidiary.

E. SHIPTON & COMPANY (HOLDINGS), LIMITED, electrical and mechanical engineers, etc., of Northwood Hills (Middx).—The directors state that negotiations are at an advanced stage for the sale of a portion of the undertaking to another public company. Further details will be announced as soon as possible.

COLTNESS IRON COMPANY, LIMITED—The dividend on the £525,002 one-class capital is maintained at 15 per cent., but last year, however, a capital payment was made of 26½ per cent. net from the sale of certain fixed assets. A fall of £9,501 in group trading profits is more than offset by a lower tax charge, so that net profit is up from £59,075 to £60,094.

PARSONS MARINE TURBINE COMPANY, LIMITED—The company has informed its shareholders that fusion with another company by means of an exchange of shares is being considered. The company also advises its shareholders not to dispose of their holdings as it is considered that the proposed merger will be advantageous in relation to current market quotations.

ENGLISH ELECTRIC COMPANY, LIMITED—A final dividend of 10 per cent. is recommended, making 14 per cent. on £15,221,721 capital (12½ per cent. including the interim dividend of 4 per cent. on £11,416,291). Group profit was £6,735,195 (£6,570,601) after providing £2,291,417 (£1,894,656) for depreciation. Taxes take £3,446,480 (£3,471,954) and £409,000 (£242,015) is transferred to capital reserve, being tax relief on capital allowances in excess of depreciation. The amount of group profit attributable to members of English Electric was £2,911,812 (£2,753,302).

J. & E. HALL, LIMITED, engineers and ironfounders, etc., of Dartford (Kent)—The company has a full order-book and speedier delivery is assisted by a certain amount of "off-loading" to sub-contractors. Output and sales value were higher in 1955-56, but the gross margin on sales tended to diminish. In order to maintain output at the highest possible level, the chairman, Lt.-Col. Lord Dudley Gordon, states that the company may be compelled to accept unremunerative prices, particularly overseas. Trading profits advanced from £476 901 to £538, 468 and the dividend is maintained at 12½ per cent.

BRITISH OXYGEN COMPANY, LIMITED—Increases in costs and the resultant lowering of profit margins have again largely offset the benefit of continued sales growth at home and overseas. Group trading profits were £5,198,464 (£4,277,152, including nine months' trading of the parent company and 12 months' for the subsidiaries). The trading profit for the past year is comparable with £4,845,639 if 12 months' trading of the parent company is included for 1954-55. Tax required £2,699,611 (£2,209,972) leaving net profits at £2,498,853 (£2,067,180). A final dividend of 6 per cent., making 10 per cent., on £17,047,166 ordinary stock as increased by a 50 per cent. scrip issue, is announced.

Forthcoming Events

MARCH 4

Institute of British Foundrymen

Sheffield and district branch: "Foundry Refractories," by a member of the British Ceramic Research Association, 7 p.m., at the Sheffield College of Commerce & Technology, Department of Engineering, Pond Street.

Institute of Industrial Supervisors

Ayrshire section: "The Foreman's Place in Management," by James Anderson, 7.30 p.m., at the Ossington Hotel, Kilmarnock.

MARCH 5

Institute of British Foundrymen

Wales and Monmouth branch: "Foundry Costing," by W. E. Harrison, 7 p.m., at the Engineers' Institute, Cardiff.

Institute of Industrial Supervisors

Swindon sub-section: "How the Metallurgist Aids Production," by K. W. Loveday, B.Sc., 7.30 p.m., at the College, Victoria Road.

MARCH 7

Institution of Production Engineers

London section: "Recent Developments in Precision Investment Casting," by W. N. Jones, 7 p.m., at Creed, Company, Limited, Telegraph House, East Croydon, Surrey.

Leeds Metallurgical Association

"Study of Wear and Lubrication Using Radio-isotopes," by J. B. P. Williamson, M.Sc., 7.15 p.m., at the Large Chemistry Theatre, The University, Leeds.

MARCH 8

Institute of British Foundrymen

London branch: "Men Only" dinner at the Duke of York's H.Q., Kings Road, Chelsea.

MARCH 9

Institute of British Foundrymen

Scottish branch: Annual business meeting and "Guides to Feeding in Theory and Practice," by J. T. Berry, B.Sc., Ph.D., and John Grice, at 2.45 p.m., followed by dinner at Grosvenor Restaurant.

Newcastle and district branch: Visit to Stella South Power Station (details from the secretary).

MARCH 13

National Society of Master Patternmakers

General Meeting: "Moulds and Cores produced by the CO_2 Process," by A. Talbot, 2.30 p.m. at the Grand Hotel, Leicester. (Preceded by luncheon, by arrangement with the secretaries before March 6.)

Contracts Open

The dates given are the latest on which tenders will be accepted. The addresses are those from which forms of tender may be obtained. Details of tenders with the reference ESB can be obtained from the Board of Trade Export Services Branch, Lacon House, Theobalds Road, London, W.C.1 (telephone: CHAncery 4411, ext. 738 or 771), unless otherwise stated.

DEWSBURY, March 7—Cast-iron pipes and specials, water meters, etc., for the year ending March 31, 1958, for the Corporation. The Water Engineer, 10, Church Street, Dewsbury.

HELSTON, March 8—Provision and laying of spun-iron water mains, for the Helston & Porthleven Water Company. Mr. F. J. Sear, secretary, Helston & Porthleven Water Company, Monument Road, Helston (Cornwall). (Deposit £5 5s., returnable.)

INDIA, March 6—Gas generating plant and equipment, for the Director General of Supplies and Disposals. (ESB/4185/57.)

MIDDLESBROUGH, March 13—Spun-iron and cast-iron pipes, etc., for the year ending March 31, 1958, for the Tees Valley Water Board. Mr. E. A. Morris, clerk of the board, Water Board Offices, Corporation Road, Middlesbrough.

SOUTH AFRICA, March 13—Rotary sand drier, for the Stores Department, South African Railways. (ESB/3801/57.)

SOUTH AFRICA, April 5—Diesel crane, for the Stores Department, South African Railways. (ESB/4175/57.)